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Engineering News-Record

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Concrete Arch Replaces Viaduct at Portland, Oregon

The Civil Engineer in Industry - IV
Industrial-Municipal Engineering

Three Articles on the Florida Hurricane Damage

Submerged Contact Aerators for Sewage Treatment

Japanese Laying Grooved Brick on a Tokio Street

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
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FRANK C. WIGHT
Editor

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The Visible Machinery Starts

MOST of the mechanism of the national government works under cover. The average citizen knows that it exists and moves only when he personally comes in contact with it and the percentage of those who do that is small. Congress, on the other hand, is visible, and audible, machinery. It has become the fashion to decry its performance and to question its efficiency, and it is a fair question whether or not this depreciation of the national legislature in the public mind is not due to its too great obtrusion on the public eye and ear. If it worked silently it might be more appreciated. After six months of retirement Congress returns this week to work, to the usual reception of critical comment. Being a short-term session, with a changing body imminent, it will do little but routine work and will, therefore, probably earn with more than usual justice the opprobrium that is showered upon it. What Congress needs is a good press agent of the familiar type that has turned certain rich men from creatures of contempt to amiable Abou Ben Adhems. There's a lot of good in it—but it does so persist in putting its worst foot forward.

Competitive Professional Bidding

DURING November the city of Topeka, Kans., circulated among engineers an advertisement asking for sealed bids "covering the appraising and making of separate physical valuations of the municipal light and water departments" of the city. The advertisement further stated that bids "may be made upon a per diem basis but to be considered must specify a total or a maximum sum covering the work" and that "firms submitting proposals shall submit qualifications along with their bids in condensed form." As a result of the advertisement, the city received a number of bids from engineers and engineering firms, but among those to whom the notice came were some engineers who recognized the ethical violation in such an advertisement and who forwarded forceful protests to the city against this obvious lack of recognition of the engineer's functions and his ethical relation to an engagement. As a result, probably, of these protests, the city has reconsidered its effort thus to obtain the services of a valuation engineer, for the city clerk in writing about the case says that the "bids received were at such variance that our engineers refused even to tabulate them and all were rejected." Apparently, this particular situation will be cleared by the effectual protests of a few engineers, but the condition revealed is significant. There will always be engineers who so lightly regard their professional obligations that the prospects of a job will lead them to discard the obvious ethical standards of the profession in this matter of sealed competitive bidding. If, however, there are in the community a sufficient number of right thinking engineers, they can, either as individuals or as a professional group, register such protest with the government authorities as to prevent the specific violation of the ethical code and to insinuate into the official mind for future reference some appreciation of what that code really means.

The More Important Victory

THE final adoption of tanks for the treatment of the sewage of Detroit after a year's delay should not be heralded as a victory for tanks over screens—the relative standing of which is well established—but for sound principles in municipal government. Three eminent consulting engineers advised tank treatment as best suited to Detroit conditions. Their report was approved by a Special Committee on Sewage Disposal, previously created by the city government. The commission was made up of eminent citizens of large business experience and the city engineer. It was further endorsed by the commissioner of public works, also an engineer. To have turned down the tank plan thus prepared and endorsed in favor of one subsequently promoted by and for a single manufacturer and not endorsed by engineers and citizens of equal standing with those mentioned would dishonor engineers and turn municipal government into a farce.

Why Not Competition?

RARELY does a city adopt a new water supply which is to be held solely for emergency use. A project of this kind, notable because of its general nature, its size and because wells are the proposed source, is now before the Board of Estimate and Apportionment of New York City. The proposal (see p. 972) which has been recommended for "consideration" by the commissioner of water supply, was made two years ago and has since been renewed and modified by a corporation which has operated for some time on Long Island, where the wells would be located. Brooklyn and Queens Boroughs already have available 112 m.g.d. of water from near-by Long Island sources but as it has to be pumped the gravity supply from the Catskill Aqueduct is used instead, when there is a sufficient surplus over the needs of Manhattan and Bronx Boroughs. The general plan of adding 150 m.g.d. for short emergency periods to the supply already available on Long Island has much to commend it but for any city to accept a wholly non-competitive offer, one not based on its own engineering studies and estimates, is against public policy except in rare cases of grave emergency. The report of the commissioner of water supply gives evidence of difficulty in judging the reasonableness of the unit price offered for the proposed wells. Some way should be devised by which the company that makes the

proposal gets credit for its initiative and enterprise and skill in developing the scheme, but there is serious doubt whether it should be by the proposed violation of the accepted principles of competitive bidding on public work.

Expert Witnesses and Lawyers

EXPERT witnesses do not have too good a standing in the common mind, mainly, it would seem, because of the readiness with which opposing sides in a legal controversy can find experts to expound the opposing views. This particular basis of disregard is not so well founded as it might be for in few things is there an incontrovertible truth. Engineers called to be experts before the court and jury, however, will do well to remember that they are facing hostile thoughts and that regardless of their professional standing they are suspected of bending their knowledge to meet a demand. Judge Hough, of the U. S. Circuit Court, in effect told the members of the American Institute of Consulting Engineers that at their meeting last month. The judge, from his long experience in patent causes where the whole issue frequently rests on the expert's testimony, warned the prospective expert that the average jury is not so simple or so ignorant as it often appears, and that while anxious for enlightenment it distrusts too assertive instruction. Opinion, not advocacy, is what judge and jury want from the expert and the more impressive he can make the former the less needed is the latter. This is good advice to the expert, but it is better advice to the lawyer who retains him. The honest expert assures himself of the righteousness of his cause before he associates himself with it, and his opinion given in court is therefore not colored by the case, but the lawyer, being by nature an advocate, is under the necessity of varying his opinion and procedure to fit emergencies. Too often he expects the expert to pursue the same course, and it is this expectation that may make the job of being an expert something that an engineer dreads. Judge Hough, we may hope, is teaching his doctrine to his own profession.

Politics and Power

IN NEW YORK STATE a pretty political drama is under way, with a presidential nomination hovering in the offing as a reward of virtue, and the "power barons" in the role of villain. Governor Smith, just re-elected to a fourth term by a magnificent majority, is by moral force attempting to prevent the Water Power Commission from granting a license under the New York State law to a private corporation to develop power on the St. Lawrence River at or about the location of the single-stage development just recommended by the American engineers on the joint St. Lawrence board. The governor is for state ownership of power, to be developed by a semi-public corporation operating under some such system as that of the Port of New York Authority. He has not been able to convert the Republican legislature to his plan but he has been instrumental in forcing a reorganization of the state offices whereby after the first of January he exercises, as governor, veto power over the acts of the Water Power Commission. His claim now is that the state, by the authorization of this revision and by his re-election, is committed to a change in water power policy and that the commission is violating express instructions in giving this last-minute license.

The commission points out that the legislature will remain Republican and will undoubtedly continue to refuse to commit the state to public ownership, that the impasse has held back proper water-power development in the state for four years, that it does not propose to allow it to continue to do so, and that it is willing to write into the contract a vitiating clause subject to the order of the coming legislature. Only those who see in private development the hand of the evil one can feel resentment at the proposed action by the commission, for the lease under the new law is fair and equitable and promises the only road to an early development of the river's power. If the proposed lessee in three years' time has not been able to compose the differences between the United States, New York State, the Province of Ontario and the Dominion of Canada, its privilege will cease and another step may be taken toward turning the St. Lawrence's flow into light and power.

As a matter of the practical future of water power development, however, there is much to be said in favor of the commission withholding action. The public ownership advocates take great delight in feeling persecuted. Every move toward private ownership is heralded abroad as a triumph of the "interests" and helps just that much to weaken a rational consideration of the power question by the public. Rather than to encourage this oppression complex by summary action of the commission it would be better, perhaps, to let the St. Lawrence development lapse for three or four years in the hope that a more enlightened view of essential economics may in that time permit a congenial legislature and governor to devise a practical power plan.

A Milestone of Progress

WHOEVER is concerned with either science or industrial technique finds it hard, surely, to realize that the U. S. Bureau of Standards is only 25 years old. It has been so intimate a partner with engineering and industry in their progress, more particularly during the last ten years, that unconsciously one thinks of it as having ever been in that same relation. Yet the fact is that the Bureau did not exist before 1901, and that its quarter-century celebration last Saturday brought together many men still young and virile who witnessed or aided its foundation.

It is instructive to think back to the prior period, when there was no great government laboratory in Washington, when industry lacked authoritative and helpful scientific aid, when the leading tests of civil engineering were made at the Watertown Arsenal, and when the government's only concern with standards was through a minor office of the Coast and Geodetic Survey, which had something to do with scale weights and measuring rules and tapes. The creative vision and enthusiasm of a few men saw beyond the Office of Weights and Measures, and their persistence brought the Bureau of Standards into being—fortunately from the first on a sufficiently ambitious scale to permit the plan to justify itself convincingly by its working results.

Simultaneously with the growth of the Bureau, engineering science has gone ahead mightily in a new era of progress, exceeding anything the art knew in the past.

This development, of course, was quite independent of the other. The Bureau has been of frequent aid to engineering science and facilitated some steps of its progress, but it did not cause or initiate that progress. It was the fullness of time that brought about the new growth of engineering science as well as the inception and development of the Bureau of Standards. As they had their beginning in the same epoch, and have gone forward hand in hand through the past quarter century, so they may fittingly celebrate their anniversary together. Last week's notable celebration at Washington to commemorate the Bureau's quarter centenary may warrant us, therefore, in setting down these lines in commemoration of the corresponding anniversary of the era of new growth of engineering science and art—to record a milestone of progress in the marvelously fertile activity of technical development which surrounds us.

This evolutionary growth has a long future before it. What has been achieved so far is but little in comparison with the possibilities still ahead, we believe. Some branches of our engineering knowledge are yet barely out of their nineteenth century atmosphere, and even the most advanced branches look ahead into broad seas of further progress. Study, questioning and revision are more active now than in any earlier year—happily so. The quarter centenary of the new engineering science marks no end point, but merely a fresh beginning. It will be the great privilege of the present and coming generations to promote and witness the growth now in preparation.

Civil Engineering in Industry

IN THIS issue is brought to a close the series of articles on some of the specialized activities of civil engineers in industry. The series has by no means covered the subject, nor exhausted the fields wherein the civil engineering training and method has been turned to novel, or at least generally unrecognized, performance. It has picked out four different types of this specialized service, and by description of individuals has illustrated methods and emphasized functions so that a picture would be drawn of the application of civil engineering to the production of goods, a new picture which we believe has not been in the eyes of the instructor in engineering or of most practitioners.

It has been shown, by examples which might have been multiplied, that engineering in industry is not concerned merely with the mechanical processes and the relation of labor to the machine but that it has an equal duty toward the plant as a series of structures. This kind of engineering comprises the multifarious details necessary to keep the physical part of the manufacturing plant in a well oiled condition. The job of such an engineer is not alone a supervision over machinery, but includes transportation, personnel and inspection. He cannot be a specialist but must take the place of the old country doctor as a general practitioner, though at the same time keeping in touch with the high lights of the modern trend in all branches of engineering.

It has been shown that there are a number of industrial plants that have built up their own technical staffs for design and construction (either or both) of all manufacturing buildings and appurtenant works. There are several reasons for this, one of which is that because of the tremendous buying power of the industry and its ability to take advantage of cash discounts, it feels that it can itself do construction work cheaper than through competitive bidding. An industry must, however, have a great deal of construction work going on continuously in order to be able to do this, as the carrying on its books of a large amount of construction plant unless it is being made constant use of would cut down any profits it might make through buying for cash. Then, too, a number of manufacturers still believe that great security reposes in keeping their processes secret and so build up technical staffs who have the same esprit de corps as any of the administrative groups in the manufacturing end. Other industries require such unusual types of structure that a certain amount of inside expert consideration is imperative.

It has been shown that many industries started in isolated localities have become indeed *the* community instead of merely a part of the community and that the engineers for such establishments are not only industrial engineers but municipal engineers and street railway engineers and power engineers, carrying the responsibility for a multitude of engineering design, construction and operation far beyond the ordinary conception of the duties of the employee or functionary of a manufacturing enterprise.

It has been shown, finally, what is perhaps not so novel as what has gone before, that in almost every industrial organization there is opportunity for the engineer who enters through the construction and maintenance end to rise to executive position where he may transplant his precise methods of thought and operation to the administration of other than the structural or mechanical phases of the business.

To call attention to these facts should be to indicate to those engineers who may not have known them that here is a field not only for personal effort but one which adds to the opportunity of the profession in general for service and to demonstrate to many unbelievers that the engineer not only puts together materials into usable form but that he says what materials are to be used and what kind of tools shall be used to put the materials together. For these enginers in industry not only control the purchase of the things they actually use in construction but they influence new processes which lead to new structural and plant requirements and therefore to new and more modern machinery and methods. This is particularly true of plant engineers wherein manufacturing processes are highly mechanized and development and research committees are continuously at work on new labor-saving machinery.

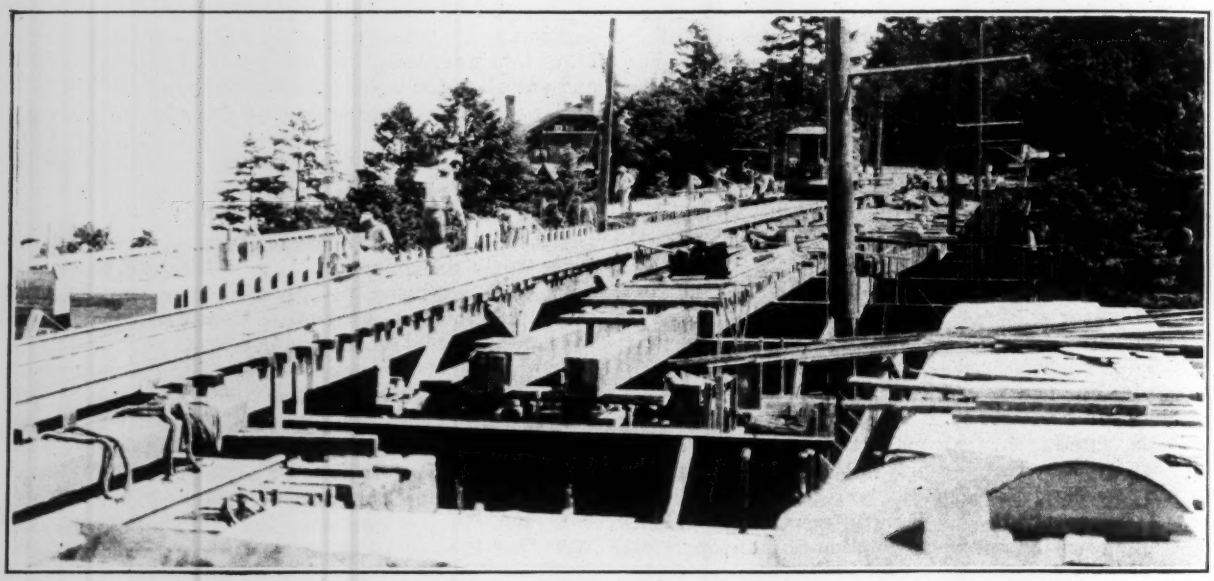
The net result of the survey is that here is an important phase of civil engineering work that too often is forgotten. Nearly twenty per cent of the subscribers to this journal can be directly assigned to it, which is as much perhaps as can be assigned to any field outside of construction. And yet those who work in it are not trained especially for it; they are merely applying their functional knowledge, that great resource of the engineer. Operations are the same, at base, whether in railroads or sewage disposal, and knowledge of and practice in functional operations are the stock in trade of the civil engineer. Some few may in time arise to the rare air of the specialist but most engineers need the general knowledge which learned in one field is readily applied to another.

Concrete Arch Replaces Viaduct at Portland, Ore.

Design and Construction Adapted to Requirements That New Bridge Be Built Without Interrupting Railway Service—Vibration in New Structure Prevented During Concreting

THE steel viaduct on Vista Avenue over Jefferson St. Canyon in Portland, Ore., which was built by the Portland Electric Railway Co. in 1905, is being replaced by a modern reinforced-concrete arch bridge with a span of 248 ft. In recent years not only has the 33-ft. roadway width on the old viaduct become inadequate but in a high-class residential district there was serious objection to the noisy timber deck and plank roadway. A wider roadway would have necessitated strengthening the structure at prohibitive cost and instead an entirely new bridge was decided upon.

During the construction period vehicular traffic could be diverted over other streets but the bridge is essential to even the present heavy grade of the street-car line serving the thickly settled Council Crest residential district and hence one of the primary considerations was a design and construction plan that would make it possible to carry out the work without interrupting the street car service.



DECK VIEW DURING CONSTRUCTION
Track temporarily supported while half the concrete floor system is being poured.

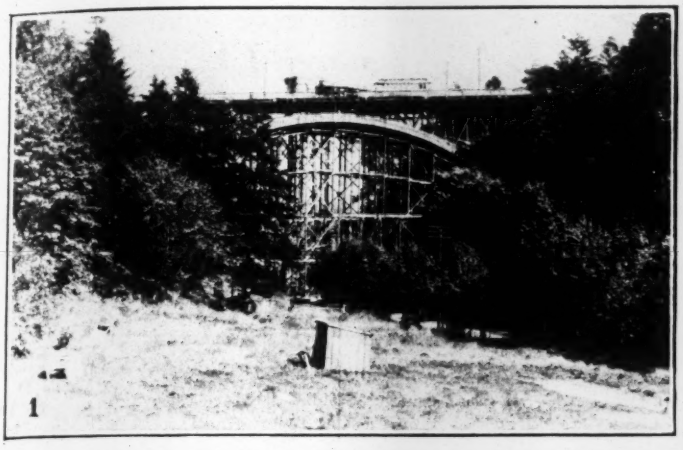
Under these conditions requirements that were important factors were (1) a floorbeam layout in the new bridge that would not interfere with the old steel floorbeams which were on 22½-ft. centers; (2) avoiding any tie between old and new structure that might transmit vibration to concrete during the setting period; (3) a design and construction program for the floor system such that all of the roadway for the full length of the bridge except the portion occupied by one existing track could be completed at one time, thus allowing one railway track to be continuously in service on one side or the other; and (4) temporary supports to replace those few members of the old structure with which interference could not be economically avoided.

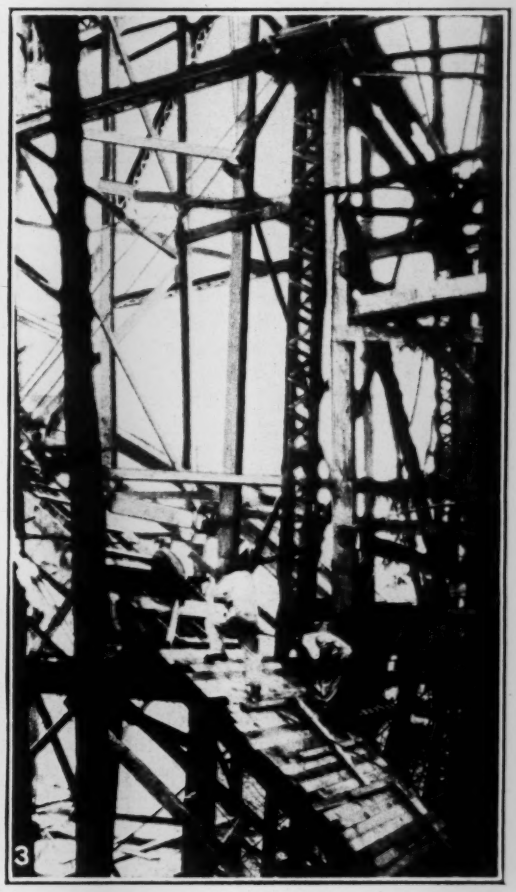
By close figuring the arch ribs were so located that it was necessary to move only one steel bent of the old viaduct. For the two batter posts of this bent which was near the south abutment, two 12x12-in. timbers, each 60 ft. long, were substituted. By placing these timbers in a vertical position they carried the load without interfering with the arch forms and the steel batter posts were then moved in at the bottom and steel wedges driven at the tops so that they would still carry a portion of the load. After taking their load the 60-ft. timbers shortened about ½ in., due, doubtless, to compression of the wood fibers at the column ends.

Some of the diagonal bracing of the viaduct was allowed to go through spandrel posts or tower forms. Where these were merely tie-rods they were cut off one inch under the surface of the concrete after the forms were removed and the holes pointed with mortar. Where structural members were involved they were incased in a board framing before concrete was poured so they could be pulled out intact after the concrete had set. The hole in the concrete was then poured full. A spacing of 20 ft. 8 in., center to center, was selected for the new floor-beams when this was found to divide the span equally as well as to miss the steel floor-beams.

The concrete used was a 1:2:4 mix in abutments, footings and towers. Elsewhere a 1:1:2 mix was used, the comparatively rich mix being considered advisable on account of limited clearance over the deck of the old structure.

With the forms set up and supported on timber bents, each arch rib was completed in four successive pours, each pour comprising a yardage that could be placed in one day. All pours except the one at the crown of the arch were made in duplicate, that is, segments of equal length were poured simultaneously on opposite sides of



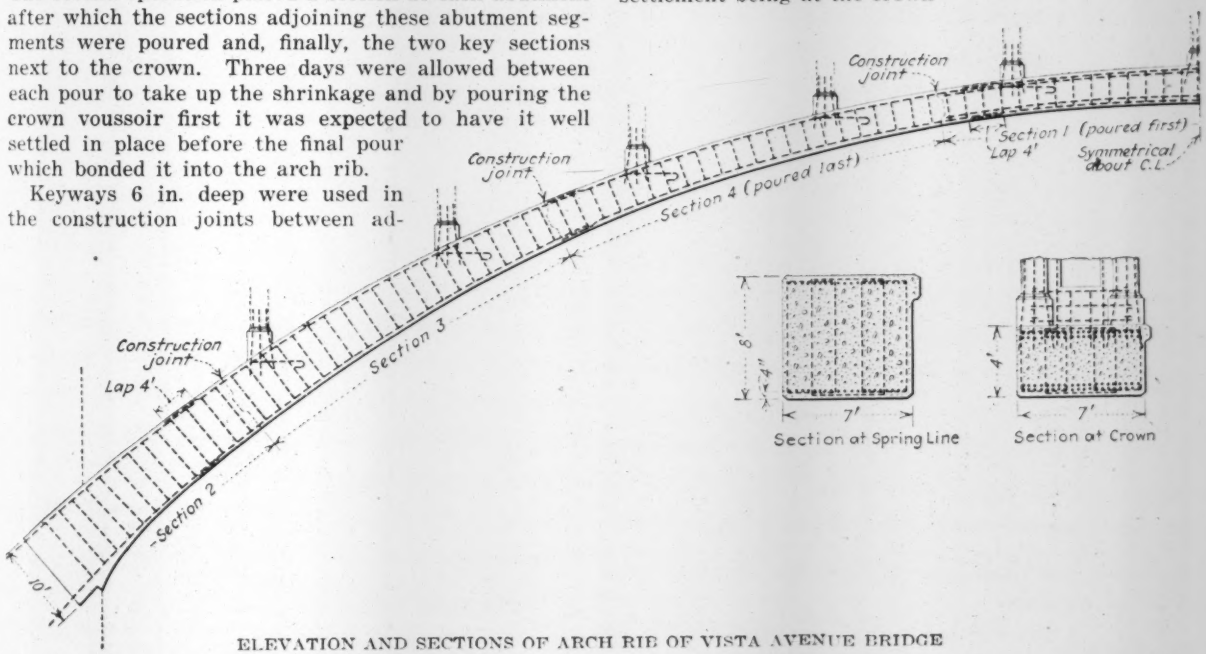


VISTA AVENUE VIADUCT AT PORTLAND

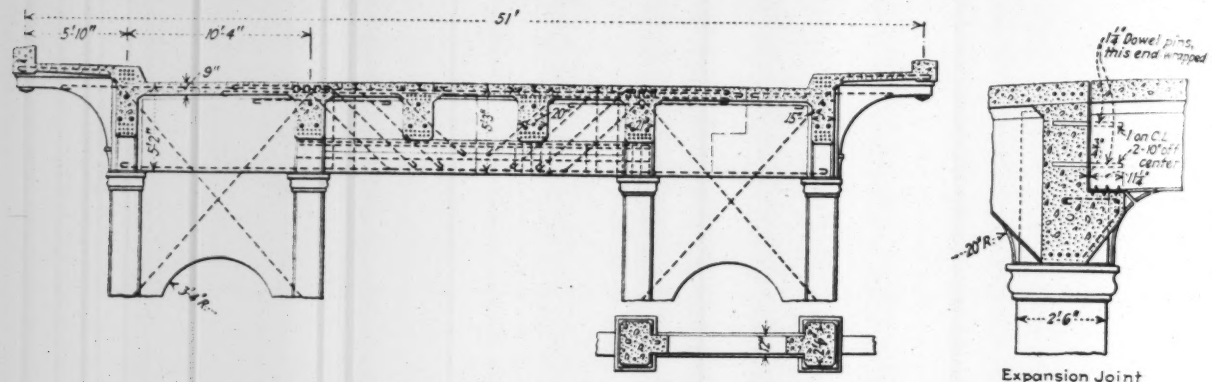
1—Forms for concrete arch. 2—Old viaduct. 3—Wood plumb posts that temporarily replaced the steel batter posts of the only bent that interfered with the arch

the arch crown. The first pour was made at the crown where a length of about 60 ft. was put in in one day. The second operation placed a section at each abutment after which the sections adjoining these abutment segments were poured and, finally, the two key sections next to the crown. Three days were allowed between each pour to take up the shrinkage and by pouring the crown voussoir first it was expected to have it well settled in place before the final pour which bonded it into the arch rib.

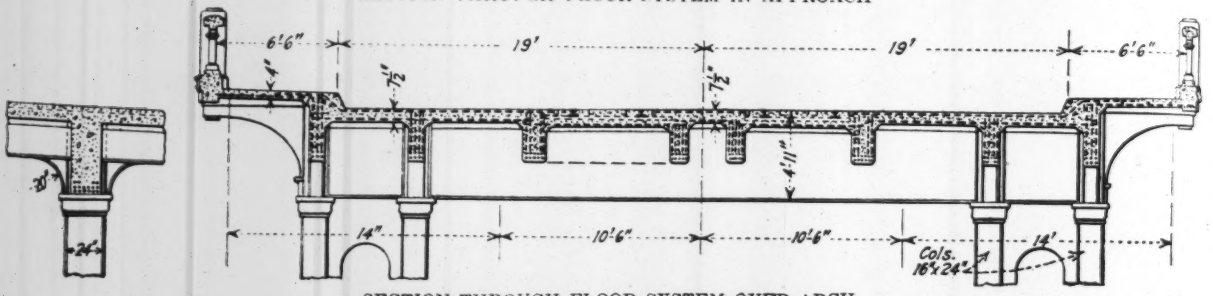
Keyways 6 in. deep were used in the construction joints between adjoining voussoirs. Under this plan of pouring a maximum settlement of 0.15 ft. occurred in the forms, this settlement being at the crown



ELEVATION AND SECTIONS OF ARCH RIB OF VISTA AVENUE BRIDGE



SECTION THROUGH FLOOR SYSTEM IN APPROACH



SECTION THROUGH FLOOR SYSTEM OVER ARCH

The roadway on the old viaduct was on a 7 per cent grade and this same grade with the floor raised 2 ft. to clear the old floor system was adopted on the new structure. The original construction consisted of three 8x16-in. stringers under each rail. These stringers were raised 1 ft. and a transverse 12x12-in. beam was put on the old steel floorbeams and held in place by 4-in. planks bolted to the steel beam. It was then possible to place the forms for the concrete floor-beams of the arch span 20 in. deep, extending entirely across the roadway. The floorbeams on the approach spans were cut entirely in two with a stepped joint to allow clearance for the old track.

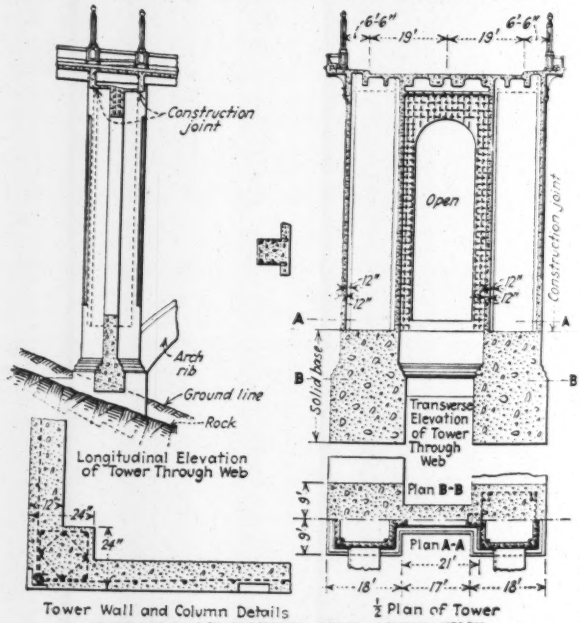
With the track in this elevated position the floor system on both sides of the old track was poured and after 28 days in which to set, ballast 6 in. deep was placed directly over the arch rib, after which the track was moved to this located and operated there until the remaining strip of the floor system had been put in and the tracks finished.

This program of construction did not make it possible to center the girders symetrically about the center line because of the necessity of leaving undisturbed enough width of roadway for the temporary track. However, the 6-in. offset involved was not considered a serious disadvantage. To facilitate track maintenance steel cross-ties were bolted in the concrete floor system. Guide rails were placed on both tracks on the bridge to minimize the danger of derailment.

In designing the structure the allowable concrete stresses were taken as 900 lb. per sq.in. in compression with a tension of 16,000 lb. per sq.in. in the steel. Floor loading consisted of on 20-ton truck with a 30 per cent impact allowance and a 50-ton derrick car with 60 per cent of the load on one set of trucks. In figuring floorbeams the loading adopted was four parallel trucks of 20-ton capacity.

The arch span has a rise of 50 ft. above the spring line and is in general of parabolic form. A deck width of 52 ft. provides for a 38-ft. roadway with two 6-ft. sidewalks. Some of the special features of the Vista Avenue arch are: Double spandrel posts and approach columns to cut down floorbeam spans; the allowance of one inch of additional concrete in the deck thickness as a wearing surface; hollow wall abutments, precast art stone made with white cement and white sand for balusters, seats and decorative features; precast "hollow-spun" concrete trolley poles; decorative illuminated portal posts and small plots for shrubbery and flowers in the entrance bays.

There is no exposed steel on the bridge; where metal is required on trolley poles or lighting standards bronze is used exclusively. Careful consideration was given to



DETAILS OF TOWER AND ABUTMENT

architectural features of the bridge because of the fact that it was located in a high-class residential district.

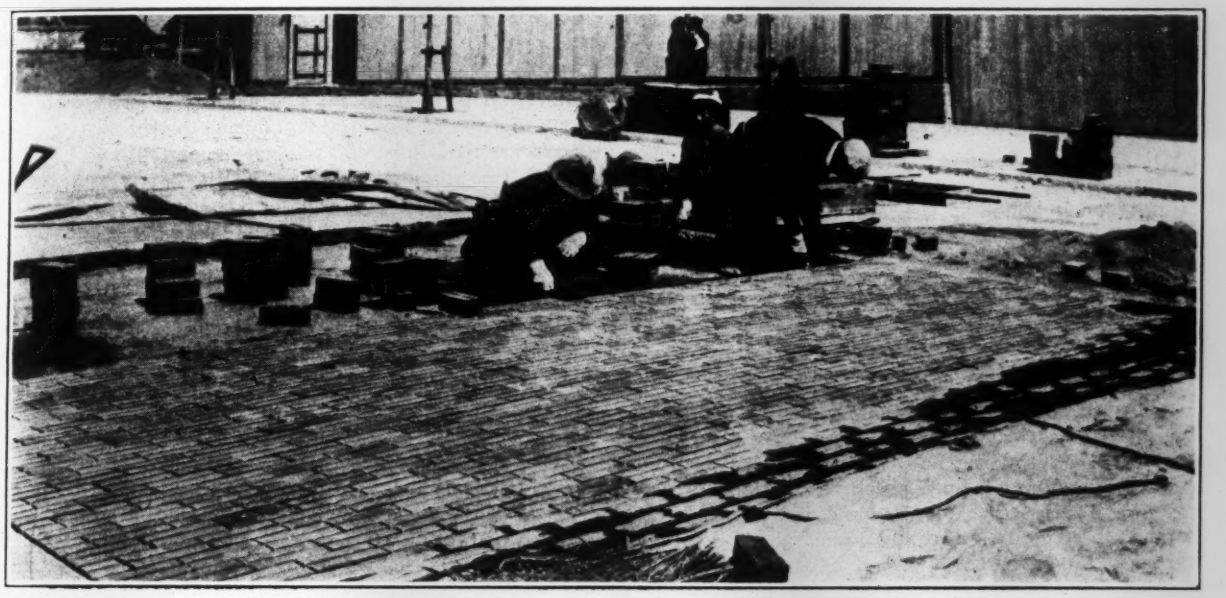
The design of the new structure was worked out by the city's engineering department; O. Laurgaard, city engineer, F. T. Fowler, bridge engineer. Contract was awarded to Parker & Banfield, Portland, for $174,870. This price included the removal of the old steel structure which then became the property of the contractor.

Grooved Brick Pavement for Grades in Tokyo, Japan

Japanese City with Prevalence of Horse Haulage Experimenting with Hillside Brick on Concrete Base

BY H. SAKAKIBARA
Tokyo, Japan

A PAVEMENT of grooved brick has recently been completed on a steep heavy-traffic street leading from the central railway station in Tokyo, Japan. The



JAPANESE PAVERS LAYING GROOVED BRICK PAVEMENT IN TOKYO

bricks are 8x4x3½ in., lugless, with a longitudinal groove in the 4-in. side on top. They are laid with mortar filler on a mortar cushion on a concrete base. Care in the mortar bed and concrete base construction are the particular features of the construction.

The subgrade of clay was graded and rolled to profile and on this the 1:3:6 concrete base was laid to crown and finished with all the exactitude of a concrete pavement using a finishing machine. Templets and straightedges were used to check the surface both transversely and longitudinally. The 1:3 mortar bed was laid ½ in. thick; a templet riding ½ in. high on the side forms struck off the mortar bed. The bricks were laid by hand, as shown by the view, using trowels and lines and filling the joints with a 1:1½ mortar. The bed mortar was machine mixed and wheeled to the work. Other details are indicated by the view. Tests of the pavement for foothold using heavy horse-drawn loads indicate that it will meet the situation.

New Water Supply for Sao Paulo, Brazil, Brought 42 Miles

A NEW water system now under construction for the city of Sao Paulo, Brazil, has its source of supply at the head waters of the Rio Claro, 42 miles from the city and about 180 ft. above the distributing reservoir. The project includes a 50-mile supply line of which 2.5 miles are tunnel, 27.5 miles are concrete aqueduct, all on the flow line, and 20 miles, some distance of which is in siphon, are riveted iron pipe, a dam impounding a lake at the upper end of the supply line, and a reservoir at the lower end. The distribution system from the reservoir into the city will be enlarged and improved.

Sao Paulo is the second city of Brazil and has a population of about 600,000. It is situated some 250 mile southwest of Rio de Janeiro, and about 30 miles northwest of the coast city of Santos.

The reinforced-concrete aqueduct which has been designed by the New Works Commission of the Sao Paulo Water Supply will be a gravity line. Three Brazilian engineering firms have been awarded contracts for constructing this part of the work, namely, the Companhia Constructora de Santos, Companhia Mechanica e Importadora de Sao Paulo, and Soares de Sampaio and Cia. Ltda. Of the 20 miles of riveted iron pipe 5 miles under 57 lb. per sq.in. pressure are 8.2 ft. in diameter and ½ in. thick, 15 miles under 114 lb. pressure are 5.9 ft. in diameter and ⅝ in. thick. Braithwaite & Co., Engineers, Ltd., Westminster, England, have been awarded the contract for supplying the pipe, which aggregates some 20,000 tons. The plates, varying in length from 19 to 26 ft., will be rolled in England, where the drilling, planing and scarfing will also be done. They will be shipped flat to the port of Santos and from there brought by rail to a fabricating plant erected near Sao Paulo by Braithwaite & Co. Fabrication will consist in rolling and riveting the pipe in lengths of 20 to 25 ft.

In those sections of the supply line which are in tunnel and under pressure a lining patented by Braith-

waite & Co. will be used. This lining is constructed of ⅜-in. iron plates hydraulically pressed to form a series of internally-flanged segments which can be bolted together as tunneling proceeds, thus forming a continuous internal lining 8.5 ft. in diameter.

Work on the project commenced in April, 1926, and more than 50 miles of new roads are now in service to facilitate transport of materials; other necessary installations such as warehouses and quarters for the laborers and engineers are being erected. Dr. Henrique de Novaes is chief engineer of the New Works Commission of the Sao Paulo Water Supply in charge of the work. This information has been supplied by the American Rolling Mill Co., Middletown, Ohio, which is furnishing the iron for the pipe and lining, through the Armco International Corporation, London.

More on General and Structural Effects of Florida Hurricane

A Group of Reports Giving Further Data on Effects of Storm—Harbor Damage at Miami —Engineers Discuss Structural Effects— Data on Wind Velocities and Anemometers

Harbor and Shore Front Effects at Miami

SOME notes on harbor and shore front damage at Miami, Fla., in the hurricane of Sept. 18 have recently been compiled by Col. Mark Brooke, of the U. S. Engineer Office at Jacksonville, and C. L. Brown, superintendent of the sub-office at Miami. In the following a summary of these notes is given:

Storm Data—The wind velocity in the storm is rated at about 125 miles per hour from the southeast. It produced a storm tide height at Miami Beach of about 6 ft., with waves some 8 ft. higher, and on the Miami waterfront along the west shore of Biscayne Bay a tide height of about 10 ft. Damage was done by tide and wave action, sometimes in combination with wind force. The effects include beach effects, damage to the causeways across Biscayne Bay and underscour or other damage to structures near the beach.

Beach Damage—Little beach cutting occurred, but instead the beaches were either left intact or large quantities of sand were washed up and carried inland. In this respect the hurricane effects differed from the usual storm wave action. Many thousand yards of sand were carried over the beach and deposited in the lower floors of buildings and on lawns of streets for a distance of 1,000 ft. back of the beach; this sand apparently came from offshore, at depths not usually affected.

The ship channel across the bay did not shoal and proved to be free of obstructions; in fact, some parts showed apparently deeper water than before the storm.

Damage to Causeways—The two causeways across the bay, connecting Miami Beach with Miami, are built of solid fill with intervening reinforced-concrete trestle sections. Both the County Causeway and the Venetian Causeway (the northerly one) were overflowed about 3 ft., and the fills were in places damaged along the north side by wave erosion, which affected most seriously that part of the County Causeway extending southeast. Damage to the concrete viaduct section was confined to the results of impact of vessels, barges and wreckage.

Shipping and Floating Plant—About 300 motor boats, house boats, rock barges and dredges were sunk, beached or otherwise damaged. In the case of large vessels damage resulted from lack of full crews aboard and lack of maneuvering or swinging room in confined channels and basins. The shore bulkheads were overtopped to a depth of at least 5 ft., and a tug drawing about this amount was carried over the bulkhead without striking it; but having steam up and a full crew aboard and her engines working she headed into the wind and against the flow of water and steamed back into the channel without damage. At another point a lighter loaded with stone was carried over the bulkhead and deposited on the municipal pier without dumping the load.

One large yacht which dragged her anchors and sank near the entrance to Miami River channel would probably have been carried against the bulkhead and suffered injury which would have sunk her. However, the vessel's ports and deadlights being open, she sank before striking. Smaller vessels were sunk by other vessels and wreckage floating against them, by impact against the bulkheads, or by being swamped. A contractor's dredge working in the government cut, which was carried by the east wind during the first part of the storm into the bay, was brought up and securely moored; when the wind shifted to the southeast the rush of water caused by the receding wind tide pulled this dredge from her moorings, out the government cut and between the jetties and around the end of the north jetty, where she sank in the ocean some hundred feet from shore.

House boats and other light craft in the Miami River were swamped; in some cases the houses covering the scows had been carried away by wind or so racked that they gave no protection against wave action. High tide and wind carried some of the smaller vessels and shallow draft barges entirely over the bulkhead and into the city streets.

* * *

Report by Palm Beach Engineers

A GENERAL study of the effects of the southern Florida hurricane of Sept. 18 was recently undertaken by the Palm Beach Engineers' Association, which appointed a committee to make the study. A report on structures has been completed by one of the subcommittees of this body, C. H. Ruggles and Theodore Eefting constituting the subcommittee. The report reviews the nature and extent of damage to different types of buildings, and in summary states that the major part of the damage was due to hurried and improper construction. It recommends as the best means of preventing similar damage in the future the revision, enlargement and enforcement of building codes, with emphasis on enforcement; the value of competent design and supervision of building work, the report states, was clearly demonstrated by the effects.

Large Structures—Noting that hardly any structural damage was done to tall buildings, except to two buildings of very narrow proportions in Miami, the report states that the resistance of other buildings although "subjected to a terrific wind load in addition to impact" shows that buildings designed under standard building codes are adequate without special allowance "except to provide as much bracing and stiffening as possible." Such damage as was done is found to be chargeable to faults and weaknesses in windows, doors, casements and curtain walls.

Smaller Buildings—Extensive losses in the class of small office, apartment and hotel buildings are attributed to the fact that many of them "were hurriedly constructed without regard to proper construction." Buildings carrying their loads on bearing walls appeared to suffer more than buildings having a structural skeleton. No one type of material seemed to show greater damage than others.

Trussed Structures—Many collapses occurred among structures having large-span trussed roofs.

> Almost without exception the ordinary garage type of building with a light wooden truss supported on walls without pilasters crumpled up and fell, whereas buildings of the same size in which properly constructed timber and steel trusses were well anchored to pilasters or columns stood up very well. Buildings of this class should have special attention paid to their structural phases and should be carefully designed with particular attention to the portion subject to indeterminate stresses. Many failures were due to wooden trusses being constructed without plans with no provision made to properly take care of the stresses developed.

Residences—Most of the property damage and loss of life were caused by the collapse of small residential buildings.

> Many of these buildings should have been put in the classification of temporary structures, being in most cases merely flimsy shells such as one would expect to find in a mining camp. . . . It is difficult to point to any class of material as being inadequate. Numerous frame houses remained standing, and evidences of careful construction characterize these. In several cases, communities in which cement block construction predominated sustained little damage. Clay tile and frame-stucco buildings also stood up well in numerous instances. On the other hand, collapses of all of the above mentioned types may be found in large quantities. The outstanding feature is that failure may be traced almost without exception to poor construction. Cement block and clay tile were laid without wetting and with insufficient and very poor mortar. . . . In the frame and frame-stucco buildings, perhaps due to large openings for ventilation, bracing was reduced to a minimum. Joists, studding and rafters were in many cases too small in size and improperly spaced. Hasty carpentry work and a lack of nails caused most of the failures in frame buildings. The most apparent damage to all residences was to the roofs. Almost all types of roof, such as composition, shingle, clay tile laid in cement, and other substantial materials suffered little when properly applied.

* * *

Wind Velocities and Robinson Anemometers

NOTES furnished by the Weather Bureau give additional information concerning wind velocities in the Florida hurricane of Sept. 18 and Robinson cup anemometers. It appears that different types of this form of anemometer are in use, some with large and some with small error. The Miami Beach anemometer was of the latter type and therefore indicated very closely the true wind velocity during the hurricane. The Miami Beach record was reproduced in our issue of Nov. 4, p. 747.

A careful study of this record was made by B. C. Kadel, in charge of the instrument division of the Weather Bureau. The anemometer was a 3-cup instrument with 5-in. cups on arms 6.29 in. long, and was located 40 ft. above ground (45 ft. above mean sea level) and 19 ft. above the roof of the building, within 1,200 ft. of the ocean, freely exposed in all directions. The recorder sheet had a speed of 2½ in. per hour. Except for slight jogs during the last ¾ hr., indicating readjustments, the record appears to be uniform and consistent, and warrants "full and complete confidence." Tests of similar instruments in the wind tunnel of the Bureau of Standards indicate that the recorded velocities are 4 to 6 miles in excess over the true wind velocities between 100 and 136 m.p.h. The greatest 5-min. rate up to 6:10 a.m. was 114 m.p.h.; after a short period of relative calm (wind velocity 78 m.p.h.) a second maximum of 128 m.p.h. occurred at 7:30, followed by velocities of 120 m.p.h. until the anemometer blew away at 8:12 a.m. All these figures represent 5-min. velocities recorded. Two-minute velocities of 138 m.p.h. at 7:40,

TABLE I—CORRECT OR TRUE VELOCITIES CORRESPONDING TO VELOCITIES INDICATED BY THE STANDARD FOUR-CUP ROBINSON ANEMOMETER OF THE WEATHER BUREAU

(In miles an hour)

Indicated velocity	0	1	2	3	4	5	6	7	8	9
0			2.2	3.2	4.2	5.1	6.0	6.9	7.8	8.6
[1]10	9.3	10.2	11.2	12.0	12.8	13.5	14.3	15.0	15.7	16.5
20	17.3	18.1	18.9	19.7	20.5	21.3	22.0	22.7	23.4	24.2
30	24.9	25.7	26.4	27.2	28.0	28.7	29.4	30.2	30.9	31.6
[2]40	32.3	33.1	33.8	34.5	35.2	36.0	36.8	37.5	38.2	38.9
50	39.7	40.5	41.3	42.0	42.7	43.4	44.1	44.9	45.6	46.3
60	47.0	47.8	48.6	49.2	50.0	50.7	51.5	52.2	52.9	53.7
70	54.4	55.1	55.8	56.5	57.2	58.0	58.7	59.4	60.1	60.9
80	61.7	62.4	63.1	63.8	64.5	65.3	66.1	66.9	67.6	68.3
[3]90	69.1	69.8	70.5	71.3	72.1	72.9	73.6	74.3	75.0	75.7
100	76.5	77.2	78.0	78.7	79.4	80.2	80.9	81.6	82.3	83.1
[4]110	83.8	84.5	85.2	85.9	86.7	87.5	88.3	89.0	89.7	90.5
120	91.3	92.0	92.7	93.5	94.2	95.0	95.8	96.4	97.1	97.9
130	98.7	99.5	100.2	101.0	101.8	102.6	103.3	104.0	104.7	105.4
140	106.2	107.0	107.8	108.6	109.3	110.1	110.8	111.5	112.2	113.0
[5]150	113.8	114.5	115.2	115.9	116.6	117.4	118.2	119.0	119.7	120.5
[5]160	121.3	122.0	122.7	123.4	124.1	124.8	125.5	126.3	127.1	127.8
[5]170	128.5	129.2	129.9	130.7	131.5	132.3	133.0	133.8	134.5	135.2
[5]180	135.9	136.6	137.3	138.1	138.9	139.6	140.3	141.1	141.8	142.5
190	143.3	144.0	144.7	145.5	146.2	146.9	147.7	148.4	149.2	149.9
200	150.7									

[1] Average velocity in the United States.
[2] Average standard of gale. Highest standard velocity by whirling machine in 1890, 35 miles an hour.
[3] Average standard of hurricane. Highest velocity by whirling machine in 1913, 67 miles an hour.
[4] Highest velocity usually recorded at exposed stations.
[5] Highest wind at the earth's surface, 186 miles an hour (indicated) on Mount Washington, January, 1876. Highest standard velocity in wind tunnel, 1922, 61 meters a second, or 137 miles an hour.

and an even higher 1-mile velocity at 7:43 (which, however, is doubtful) are noted. The figure of 138 m.p.h. maintained for 2 miles is corrected by the known anemometer error to 132 m.p.h. actual maximum velocity, which Mr. Kadel computes by 0.0033 V^2 as equal to a pressure of 57 lb. per sq.ft. on a flat surface normal to the wind. From records made with a Dines pressure tube anemometer at Washington it has been found that winds with 1-mile velocities between 40 and 50 m.p.h. contain individual gusts 30 per cent higher, which would indicate, if the same ratio of gust excess applies to the conditions of the Florida hurricane, a maximum gust velocity of about 172 m.p.h. actual.

Other records of high winds in the United States include: 186 m.p.h. recorded, Mount Washington, N. H., 4 a.m., Jan. 11, 1876, 4-cup anemometer, corresponding to true velocity 140 m.p.h.; 138 m.p.h. recorded, Cape Lookout, N. C., Aug. 18, 1879, corresponding to true velocity 105 m.p.h. (but after the collapse of the anemometer the observer estimated the maximum velocity at 165, corresponding to true velocity of 125); 115 recorded, 88 true, Mobile, Oct. 18, 1916; 114 recorded, 87 true, Pensacola, Oct. 18, 1916 (followed by estimated maximum of 120, true value 91, after the destruction of the anemometer); and 126 recorded, 96 true, North Head, Wash., Jan. 29, 1921 (with 1-min. maximum of 150, true value 114). As the former record was made with a non-automatic instrument, Mr. Kadel

says "The Miami Beach record therefore stands as the highest made by automatic instruments in the United States."

Robinson Anemometer Errors—As to the Robinson anemometer and its continued use, C. F. Marvin, chief of the Weather Bureau, states that this instrument has been used by the Bureau from its organization in the 1870's at all of its stations. The cup type of instrument was invented about 1846 by Dr. Robinson, who said that the centers of the cups move one-third as fast as the wind; but this relation was shown to be wrong in 1888, when tests on a whirling machine proved it to be increasingly in error at high velocities, up to the test maximum of 60 m.p.h. During recent years higher test velocities, applied in wind tunnels, showed the error to increase still more in the higher range. The original plan of reporting the anemometer velocities was continued, however, as "it was thought best to continue the records of the Weather Bureau uniformly on the old system rather than to attempt to apply a correction only partly known."

Recently the cup of the instrument has been improved in form and dimensions to bring about a linear relation between cup movement and wind movement, so that anemometers are now available which give true velocities direct, within allowable tolerances. The new instrument is to be introduced as soon as funds permit. For the present, the old instrument continues in use and all records are affected by the error of the original type. The Miami Beach anemometer was of the new 3-cup style, and corrections therefore are small.

Gust Velocities—Gust velocities have been studied by pressure anemometers, of which the Weather Bureau has three (at Washington, at Central Park, N. Y., and at the University of Chicago). Examination of some of the Washington records with this instrument shows the following relations between 5 min., 1 mile, and maximum gust velocity.

TABLE II—WIND AND GUST VELOCITIES, MILES PER HOUR
Observations at Washington, D. C., with Recording Anemometer of Pressure Type

Date, 1924	Mar. 16	Apr. 20	May 11	June 18	Sept. 2
5-min. maximum, indicated	36	46	30	36	48
corrected	29.4	36.8	24.9	29.4	38.2
One-mile maximum indicated	40	52	32	42	54
corrected	33.3	42.2	27.3	34.1	43.7
Highest gust	47	53	32	51	57
Excess of gust above 1-mile max.	41%	26%	17%	50%	30%

The velocities here represented all are relatively low, and it is not known whether similar percentages of increase hold for gale and hurricane velocities.

Pressure tube anemometers such as the Dines have not yet been thought practicable for regular use at Weather Bureau stations on account of cost, expensive maintenance, operating difficulties, the impracticability of remote recording, and the high chart speed required.

As to the location of weather observing stations, Mr. Marvin says:

"The modern skyscraper is our most serious problem. The federal buildings in which the Weather Bureau has office rent free are frequently overtopped by nearby higher buildings. To remove any considerable number of these offices to the higher buildings would require rental costs beyond the resources of the Bureau and at the same time would involve complications in measuring the rainfall."

Submerged Contact-Aerators for Sewage Treatment

May Be Combined With Old or New Settling Tanks and Require Only 0.1 Cu. Ft. of Air per U. S. Gallon

By Dr. Karl Imhoff
Chief Engineer of the Ruhrverband, Essen, Germany

CONTACT aerators are submerged aerated contact filters. They work in the sewage and cause no loss of head. In this they differ from trickling filters and contact beds of the fill-and-draw type both of which work in free air and need a head of sewage corresponding to their full depth. These aerators, which may be placed in either old or new settling tanks, are economical, especially where complete treatment of the sewage is unnecessary.

The artificial aeration of trickling filters as well as of contact beds is often mentioned, but it never was a success in large plants. The oldest publication known to the writer is the American patent 535,515 of 1891, granted to George E. Waring, Jr. Contact aerators built from wooden lath were tried by Black and Phelps in 1910 (Phelps, *Public Health Engineering*, 1925, p. 115). Stroganoff (Moscow) reports experiments with "aerofilters." These are aerated trickling filters with return of activated sludge. Experiments made at Essen, Germany, seem to show that Stroganoff trickling filters have three times the efficiency of ordinary trickling filters—due not to artificial aeration but to returning activated sludge to the filters, which is known since 1902 (Austrian Candy patent 18,442).

Suggested by a publication of Dr. A. M. Buswell (*Engineering News-Record*, May 10, 1925, p. 835) and after a visit by the writer to Dr. Buswell's experimental plant of Urbana, Ill., in May, 1925, the Ruhrverband began to install contact aerators in three two-story tank plants. A sketch of the oldest plant at Kettwig, a city of 6,000 population in the Ruhr district, is shown herewith.

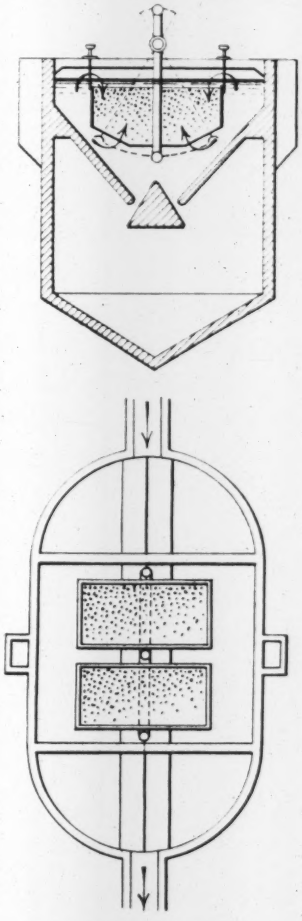
The two main features of the Kettwig contact aerators are: (1) The circulation of the sewage. The aerator consisting of brushwood is surrounded with wooden walls. When air is blown from the bottom, the mixture of water and air inside the walls is lighter than the water outside. So during aeration the sewage circulates upwards through the contact aerator and downward through the free space of the tank. Each particle of sewage touches many times the biological growth on the brushwood of the contact aerators. (2) The moving air pipe. One pipe about 6 ft. long suspended like a pendulum serves the whole bottom area of a contact aerator box 10 ft. square. The flushing power of the air is always concentrated on one line and deposits are flushed out in the circulation flow of the sewage. The Kettwig aerators are situated inside the upper settling story of two-story tanks. So the flushed out deposits pass down into the lower story for digesting.

The efficiency of the aerators with short period treatment is surprisingly high. In settling basins of two hours' capacity where the aerators occupy the middle third of the length so that one third serves for preliminary settling and another third for final settling, the effluent was almost non-putrescible with weak sew-

age. With strong sewage the biological purification was more than half. Compared with the plain sedimentation of two hours without aerators the results were:

	Without Contact Aerator	With Contact Aerator
	One-third Size of Tank	
Strong sewage	600	200 mg. K Mn O_4 consumed
Weak sewage	130	60 mg. K Mn O_4 consumed

These results are very remarkable compared with the costs of the aerators. The construction costs are only 5 to 10 per cent of the costs of the two-story tanks and the power consumption is only 1 to 1½ hp. per U.S.m.g., the air quantity being 0.1 cu.ft. per U.S.g.



CONTACT AERATOR IN TWO-STORY TANK

It is uncertain whether the contact aerators would be economical where full biological treatment equal to the efficiency of a good activated-sludge plant is necessary, but they promise to be economical for certain conditions, as: (1) For partial purification that occurs in cases where settling is not sufficient and full biological treatment is not necessary. It is well known that trickling filters cannot be overloaded. They can not be used for partial purification. From the Birmingham experience it is doubtful whether the activated-sludge system is economical for partial purification since the power consumption of the reaeration of the overworked sludge is not much lower than it would be for full biological treatment. But the contact aerators of the Kettwig design can be overloaded to any degree. The efficiency diminishes but the deposits are always washed out and the growths on the brushwood remain well aerated and healthy. (2) For preliminary treatment in trickling filter plants or activated-sludge plants. The Essen experiments showed that the capacity of an activated-sludge plant could be doubled with preliminary treatment in contact aerators. This improvement especially will be suitable for overloaded trickling filters and activated-sludge plants which otherwise have to be enlarged. (3) For city sewage with certain kinds of dangerous industrial wastes. The contact aerators are less sensible to disturbances than are other devices. Dr. Bach of Essen has used contact aerators with success for phenol wastes and for acid starch factory waste. In Kettwig the aerators are not disturbed by great quantities of wool-washing grease. Fat and grease which would not be removed by settling rise and 60 to 70 per cent is removed as foam.

These are the results of a few plants with not much over a year's practical experience. But they indicate that contact aerators can be as useful in sewage treatment as sprinkling filters or the activated-sludge process, while under certain conditions they are more economical, especially where only partial treatment is required. Contact aerators can easily be placed in existing sedimentation tanks, either one-story or two-story.

Railroad Expenditures Continue High

CAPITAL expenditures made by the Class I railroads during the first nine months this year for improvements to the transportation plant and for the expansion of its capacity, including improvements in and additions to railway facilities, locomotives and cars, totaled $629,000,000, according to a report submitted by the Bureau of Railway Economics of the American Railway Association at the annual meeting of that association. On the basis of capital expenditures made during the first nine months this year, it is estimated that the total capital expenditures for the year will amount to $875,000,000.

This estimate for 1926 compares with actual capital expenditures since 1920 as follows:

1920	$653,267,000
1921	557,035,000
1922	429,273,000
1923	1,059,149,000
1924	874,743,000
1925	748,191,000
1926 (Est.)	875,000,000
Grand Total (7 years)	$5,196,658,000

This indicates an approximate aggregate of railway capital expenditures, during the seven years since the close of the period of federal control, of nearly $5,200,000,000 or about $750,000,000 annually and an annual average during the past four years of $890,000,000.

While the actual expenditures made from Jan. 1 to Oct. 1 this year amounted to $629,000,000, the railway managements during that period have actually authorized capital expenditures amounting to $1,175,000,000. This includes $475,000,000 in unexpended authorizations brought over from 1925.

Capital expenditures for equipment during the first nine months amounted to $271,023,000, an increase of $15,130,000 over the corresponding period of 1925.

For locomotives, expenditures amounted to $72,324,000, an increase of approximately $30,000,000 over the same period last year. For freight cars, $143,265,000 were expended, a decrease of $31,107,000 under the year before, while for passenger train cars, $43,403,000 were spent compared with $29,645,000 the year before.

Capital expenditures for roadway and structures in the nine months period this year amounted to $358,070,000, an increase of nearly $79,000,000 compared with the first nine months last year. Of this amount, $124,084,000 was expended for additional track, an increase of nearly $25,000,000 over 1925, while $29,531,000 went for heavier rails, an increase of $4,500,000. For additional ballast, $12,059,000 was expended in the nine months period this year or $4,000,000 more than in the preceding year. For shops and engine houses, including machinery and tools, capital expenditures amounted to $29,115,000 compared with $22,676,000 in 1925. All other expenditures amounted to $163,281,000 compared with $123,878,000 during the first nine months of 1925.

Treatment of Algae and Weeds in Lakes at Madison

Obnoxious Conditions of Lake Waters Investigated and Remedied—Sodium Arsenite and Sulphate of Copper Applied by Dragging and Spraying—Weed Cutting

By Bernard P. Domogalla
City Bio-Chemist, Madison, Wis.

BAD conditions due to vegetable growths in the five lakes in the vicinity of Madison, Wis., have been the subject of scientific investigations for a number of years. In 1925, intensive studies were made and remedial measures applied to Lake Monona, this being the one whose condition is most noticeable in the city. Special attention was given to the bio-chemical fluctuations that take place in these lakes and to the factors that influence these changes: stratification, circulation, temperatures, light, oxygen supply, agricultural and industrial nature of the watershed as well as the inflowing drainage and ground waters. Copper sulphate to keep down the algae growth and elimination of weeds by cutting machines or cables and by arsenite compounds are the remedies applied. Phosphorus and nitrogen were decided factors in increasing the growth.

FIG. 1—CHAIN OF LAKES AT MADISON, WIS.

Lakes Mendota, Monona, Waubesa, Kegonsa and Wingra, forming a chain of glacial hard-water lakes in the Yahara River valley (Fig. 1) are in drift basins and are fed from ground waters and small affluents. Their dimensions and other features are given in Table I. Lakes Mendota and Wingra flow into Lake Monona, which also receives 5 to 6 m.g.d. of treated sewage. For the most part the shore line, as well as the main body of Lake Mendota, is clear and clean. Lake Wingra, in contrast, is shallow and a luxuriant growth of vegetation along its margin feeds upon the high nitrates and other food constituents that enter this lake by means of springs and creeks. The conditions of the other three lakes lie between these two extremes. In summer the surface temperature generally reaches a maximum of 77 to 82 deg. F. During the summer and winter months the waters are well stratified, the surface waters differ markedly from the bottom waters, physically, chemically and biologically.

Collection and Analysis—By means of special apparatus (Fig. 2) chemical, biological and bacteriological bi-weekly water samples were collected at various depths from different sections of the lakes. For the biological examinations, the method developed by Birge and Juday was followed instead of the Sedgwick-Rafter method. A definite quantity of the fresh water is centrifuged through a special high-speed electric centrifuge made at the University of Wisconsin. The plankton (plant and animal life) is collected in 4.5 c.c. of centrifuge bowl water which is diluted to a definite volume. Of this concentrate 1 c.c. is transferred into a Sedgwick-Rafter counting cell, and the various organisms are counted under low power with an ocular micrometer. Twenty counts are made from each sample in the counting cell and the total count is then multiplied by a factor which gives the total number of organisms in one liter of water. The plankton counts are correlated with the organic matter found in these organisms. For the determination of the organic matter, one liter of the fresh water is centrifuged and the bowl water is washed in a platinum dish, dried, weighed, ignited in a muffle furnace and weighed again.

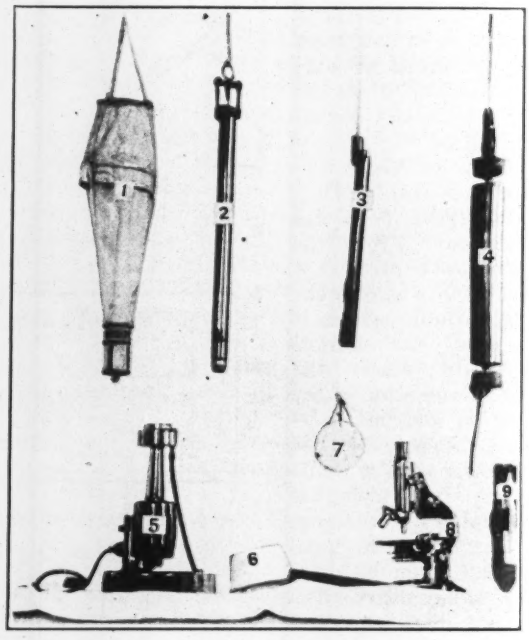


FIG. 2—APPARATUS FOR LAKE INVESTIGATIONS

1—Net for plankton catch. 2—Mud sampler. 3—Deepsea thermometer. 4—Water sampler for taking samples at any depth. 5—High-speed electric centrifuge. 6—Dipper for macroscopic work on the lakes. 7—Disk for determining clearness of water. 8—Microscope. 9—Bacteriological sampler for determining bacteria at different depths. 2 and 4 and casing of 3 designed at the University of Wisconsin and 5 made at the University.

Copper Sulphate Treatment of Lake Monona—Based upon the analyses of the samples taken from the different sections of the lake, copper-sulphate treatments were made during 1925. In former years copper sulphate had been applied intermittently without apparent success, for the algae grew vigorously all over the lake, and at the same time gave off disagreeable odors and formed green scums. Last year the treatment was done under scientific supervision and with great care, for many people in Madison had come to believe that it was

FIG. 4—EFFECT OF CHEMICAL TREATMENT ON LAKE MENDOTA, AUGUST, 1926
At left, water densely populated with algae and weeds. At right, eight days after treatment with sodium arsenite.

impossible to eliminate this lake nuisance at reasonable cost. Investigations have shown that it is cheaper to kill the objectionable growths as they start and before the organisms have developed to such extent as to form a heavy mass.

Two methods of distributing the copper sulphate in the lake were applied, bag dragging and spraying. About 50 lb. of the crystals of copper sulphate were placed in burlap sacks; one was suspended in the surface water from each side of a large launch which was motored up and down the section of the lake where the algae thrived or were found to be getting a fresh start as brought out by the microscope examination. The launch was operated at a speed that would distribute the required amount of copper sulphate as systematically and as uniformly as possible. The spraying method was applied on calm waters to the type of algae that came to the surface. Copper-sulphate crystals were placed in brass hand sprayers which were then filled with lake water and stirred. In shallow waters the spraying was done with a minimum of stirring of the waters or the bottom mud or debris. For certain algae a large power sprayer mounted on a scow, as in Fig. 3, was used during the season of 1926. The results obtained with the spraying method have shown it to be more effective and economical than the dragging method.

The copper-sulphate treatment of Lake Monona in 1925 was begun early in May and was continued to Sept. 6 when cool weather ended the trouble. A total of 108,600 lb. was used, as follows: May, 11,350 lb.; June, 30,650 lb.; July, 25,250 lb.; August, 34,550 lb.; September, 6,800 lb. At no time did we add the required 1 or 2 lb. per m.g. of water on the basis of the entire volume of the lake. The 30,000 lb. per month added during the active growing season was estimated on the basis of the volume of water in the lake to a depth of 15 ft. In applying the copper sulphate care was taken, especially in the bays and shallow waters, to keep the total concentration below 6 lb. per m.g., which Whipple states will kill fish.

At no time were the algae in the lake entirely eliminated. However, the greater portion of the lake was clear and in a better condition than the other lakes of this chain. The turbidity or white disk readings averaged around 12 ft. for Lake Monona, whereas the disk readings of the other lakes ranged from 2 to 6 ft. during the summer months. The growth and disappearance of the algae were watched almost daily so as to apply the copper as economically and effectively as possible. A great number of counts as well as other analyses were made in order to determine the effect that various treatments had on the condition of the lake water and to make a treatment for certain algae as soon as a marked increase in the algae count was noted. Tables II and III show the effect that copper sulphate had upon the predominating forms of algae. After three or four days one could first notice a marked disappearance of the algae. The investigation also brought out the fact that some algae were more sensitive to copper sulphate treatment than others. In many cases during a treatment the predominant form was greatly reduced in numbers and then some of the minor forms multiplied faster and became the predominant algae in the water.

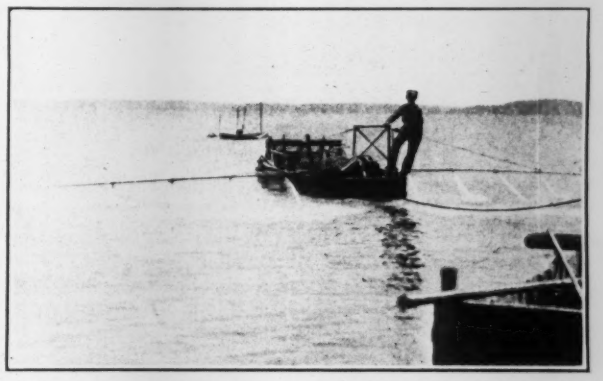


FIG. 3—SPRAYING CHEMICAL ON LAKE MONONA; 1926

Procession of Algae Types—In May, Cladophora was the chief alga that caused trouble along the shore. Large masses would come loose from the rocks and other material along the bottom of the shore line and float on the surface. Fortunately during May and the early part of June large numbers of Daphnia would swarm about at night in the surface waters and live on the algae, so that much copper sulphate was saved. Late in June, Anabaena multiplied very rapidly over the entire lake. It was so sensitive to our method of treatment that it never again appeared in great numbers in Lake Monona during the summer, although it could be found in large numbers in other lakes. Early in July, Pediastrum became predominant for a short time. As soon as we had them well under control Hydrodictyon appeared quite strongly, followed by the offensive Microcystis. The latter was more sensitive to our treatment

than Hydrodictyon, which at times became very obnoxious and floated about on the surface in large masses. The close inspection of the bays and shallow shore lines pointed to the fact that these places were the breeding centers for many of the algae; the weeds in these areas afforded them some protection from the copper sulphate solution.

During most of the summer, Lake Monona was kept in good condition, but during the first week in August our supply of copper sulphate was depleted, so that

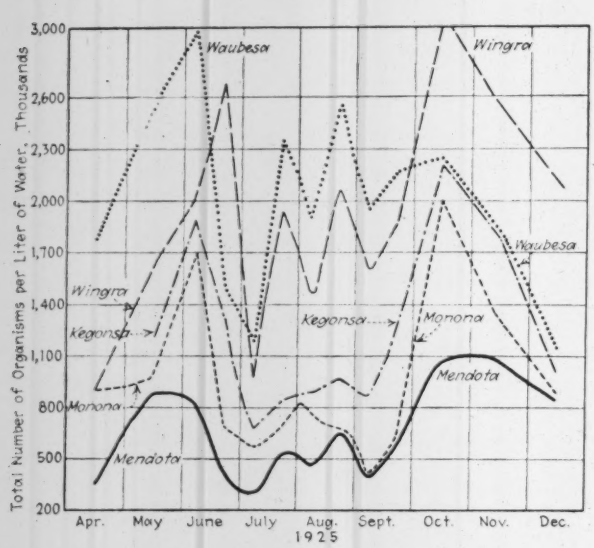


FIG. 5—PLANKTON COUNTS ON MADISON LAKES

before the new shipment arrived the entire surface was full of scum and bad odors were developing. By means of both the spraying and dragging method this bad condition was almost removed in four days. This rapid removal of the surface scum convinced skeptical observers that copper sulphate was the effective means in the treatment of algae, and that the weather or the "elements" were not the agents that were keeping the lake in good condition. While Lake Monona was kept in good condition some of the neighboring lakes were densely populated with algae.

A comparison of the total plankton counts and the organic matter present in these lakes is shown in Figs. 5 and 6. The data given in these curves are the averages for the entire lake and not for any particular bay or area. The high plankton count during the spring and fall months is due chiefly to the great number of protozoa in the water, whereas during the summer months various types of algae predominated. Lake Wingra being a small spring-fed lake showed a higher count of protozoa and diatoms during the summer months than did the other lakes. Lakes Waubesa and Kegonsa had a series of "spells" worse than those in Lake Monona.

Early in the summer, it was found, the waters of Lake Waubesa were filled with Aphanizomenon, then later came masses of Anabaena, which were soon followed by Lyngbya and Microcystis. The Microcystis scum and bad odors lasted for several weeks. Until late in the fall Lyngbya and Microcystis were still the predominant algae in Lake Waubesa. In Lake Kegonsa, Anabaena was the most obnoxious alga during early July; Anabaena was followed by Rivularia, then by Microcystis and late in the summer again by Rivularia.

The curves showing the amount of organic matter present in the chain of lakes indicate the mass of possible putrescible matter in the water. The decay of this organic material reduces the dissolved-oxygen content and also contributes to bad odors, appearances and tastes. In studying these curves on the organic matter a conception can be drawn of the great mass of living material growing in these lakes. During August, Lake Monona had a standing crop of 4 tons per acre of surface water, weeds not included.

Weed Treatment—Two methods of removing water weeds were applied on Lake Monona. Most of the cutting was done by a power-driven weed-cutting machine mounted on a scow, Fig. 8. The cutter was designed to cut a 10-ft. swath about 3 to 4 ft. below the surface of the water. The loose weeds would float about the lake with the wind and men had to be employed to remove them as they were washed to the shore.

Toward the close of the season, steel cables were

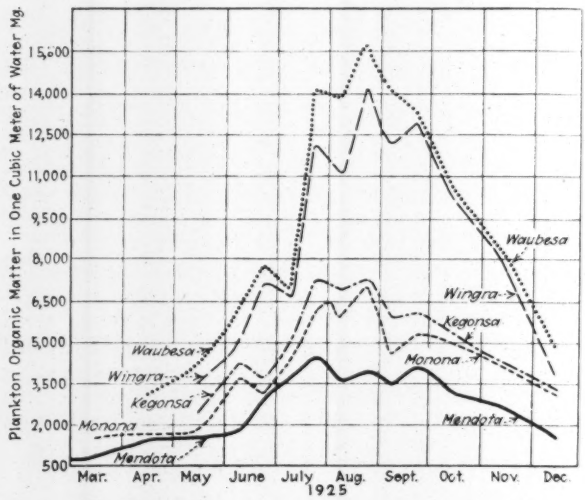


FIG. 6—PLANKTON ORGANIC MATTER IN LAKES

tried in an endeavor to find a more efficient means of removing the great mass of weeds that thrive in all of the shallow parts of the lake, chiefly pond weeds (Potamogeton), water crowfoot (Ranunculus), eel grass, bullrush and duckweeds. Before the cable method was tried, one could barely row a boat through a triangular bay at one end of the lake. To the 1,000 ft. of ¾-in. steel cable, clips were attached every 10 to 20 ft., around which the weeds were caught. The cable was unreeled into the water in the shape of a large loop. One end of the cable was securely fastened to a driven post, and

TABLE I—DATA ON CHAIN OF LAKES AROUND MADISON, WIS.

Lake	Length, Miles	Width, Miles	Area, Sq. Miles	Max. Depth, Ft.	Mean Depth, Ft.	Volume, M.G.	Ave. Drop Between Lakes, In.
Mendota...	5.90	4.60	15.20	84.0	39.7	126,385.35	36.0
Monona....	4.16	2.40	5.44	74.0	27.6	31,409.95	3.4
Waubesa..	4.20	1.40	3.18	36.6	16.1	10,634.58	18.0
Kegonsa....	3.00	2.25	4.91	31.4	15.1	15,603.63	....
Wingra.....	1.00	0.37	....	14.1	8.9	1,479.52	....

the other end was attached to a truck which slowly pulled the cables from the water, as shown in Fig. 7.

Before cabling, copper spraying experiments were

FIG. 7—GATHERING WEEDS BY CABLE; LAKE MONONA, 1926
At left, weeds being dragged by cable. At right, hauling in cable by hoist and tractor.

tried on this bay. The results of the spraying alone were remarkable, with the use of but one-third the amount of copper that was used on the same bay formerly by the bag-dragging method. Cabling was found to be so effective for certain weeds that this method of removal was used more extensively during the 1926 season, when 300 tons of weeds with most of their roots were removed by this method. Since the duckweed could not be removed by either the cutting machine or by the cables, arsenical compounds were found to be very effective in destroying this and other water weeds. Fig. 4 shows the change of condition.

Role of Nitrogen and Phosphorus—Marked variations in the different forms of nitrogen and phosphorus were found in these lakes. The chief sources of nitrogen and phosphorus are from the inflowing waters as well as from the decomposition of the organic material contained in the mud and debris at the bottom of the lake. During the spring and fall turnovers the accumulated forms of soluble nitrogen and phosphorus in the lower strata are mixed with the surface waters and thus increase the surface food supply. The total amount of organic nitrogen increased in all of the lakes as soon as the plankton increased. Lake Waubesa, which had the largest amount of algae growing in its waters, showed a higher organic nitrogen content than the other lakes. On the other hand the ammonia and nitrates, as well as the soluble phosphorus, made a marked drop during the growing season in all of the lakes.

The fluctuation in these forms in Lake Monona needs further explanation. As the algae crop increased, the ammonia, nitrate and phosphorus content dropped, yet not so markedly as in the other lakes. The copper treatment reduced the algae crop and at times the forms of nitrogen and phosphorus increased during the summer months. On one occasion, these forms showed a very sudden decrease which was correlated with a heavy algal growth over the entire lake. This incident occurred during the first week in August when the copper supply became exhausted. As soon as the treatments were begun again the forms of nitrogen and especially the phosphorus made a rather sudden rise. These investigations thus point out the great importance that the presence or absence of phosphorus has to the growth of algae in particular. At all times the waters of Lakes Waubesa and Kegonsa showed a higher phosphorus content than those of Lake Monona, which is their source of supply. Further investigations have shown that Lakes Waubesa and Kegonsa obtain a great portion of their supply of phosphorus from the drainage waters of the surrounding farm and marsh lands.

The bacterial examination brought out the fact that both nitrification and nitrate reduction are going on in these lakes. In winter and spring nitrification is more rapid than nitrate reduction, whereas during the

FIG. 8—WEED CUTTING MACHINE

TABLE II—LAKE MONONA PLANKTON COUNT, BRITTINGHAM BAY
Sample by means of copper-dragging method, 600 lb. of copper sulphate were applied June 14, 1925. Number per liter of water

	June 14 Before Treatment	1 Day After	3 Days After	5 Days After	10 Days After
Microcystis	77,952	70,952	40,230	40,250	40,368
Coelastrum	59,304	51,100	37,104	37,000	39,675
Pediastrum	51,312	48,250	31,776	42,250	51,312
Fragilaria	44,208	39,580	30,885	33,550	49,104
Aphanizomenon	40,100	37,775	30,000	31,750	38,500
Hydrodictyon	35,850	33,150	26,500	29,950	44,950
Scenedesums	33,775	30,680	20,950	21,000	28,775
Anabaena	30,525	28,760	21,800	23,215	27,325
Total number*	573,026	501,250	389,245	410,775	493,050

*This total includes the other minor algae, protozoa, etc.

summer the reverse is generally true. Bacterial nitrate reduction was found more rapid during the summer months in Lakes Wingra and Kegonsa than in the other lakes. The rate of nitrification in the summer in Lake Waubesa was rather rapid and thus contributed additional nitrate food to the vigorous algae crop in this lake.

Conclusions—These investigations and experimental methods have brought out important points to be considered in improving various bodies of waters: (1) The copper-sulphate dragging method is preferable for the type of algae that does not rise to the surface of the water and where the lake is well stirred by the wind; from 1 to 2 lb. of copper sulphate per m.g. are effective in practically eliminating these forms; (2) the spraying method is more efficient where the algae come to the surface, and for very shallow water where a boat would stir up the bottom mud and debris; (3) weeds growing in large bodies of open water may be kept under control by a weed-cutting machine; (4) in shallow places and along shore lines, weeds may best be removed, both the roots and the foliage, by means of steel cables with clips and swivels attached to them; (5) arsenical compounds have been found to destroy a variety of water weeds; (6) soluble phosphorus, the different forms of nitrogen, as well as the type of bacterial flora living in the waters are the growth-promoting factors for the algae and weeds.

TABLE III—LAKE MONONA PLANKTON COUNT AFTER COPPER SPRAYING

At the Triangle Bay between the Railroad Crossings and South Madison 100 lb. were sprayed on Aug. 12, 1925. Number per liter of water

	Aug. 12 Before Treatment	1 Day After	3 Days After	5 Days After	15 Days After
Synedra	127,872	96,615	26,997	18,473	24,156
Aphanocapsa	107,981	78,144	21,315	12,789	18,473
Pediastrum	93,773	58,253	17,062	18,473	38,417
Scenedesmus	83,828	35,521	12,789	15,631	45,521
Pandorina	71,040	44,046	9,947	9,947	25,831
Coelastrum	61,095	26,997	7,105	8,526	12,789
Microcystis	44,046	21,315	1,421	1,421	9,967
Hydrodictyon	62,516	17,052	1,421	710	8,526
Fragilaria	36,942	14,210	2,842	1,421	11,368
Total number*	877,510	550,679	195,899	138,811	247,896

*This total includes the other minor algae, protozoa, etc.

The laboratory work was done by the writer in the Wisconsin State Laboratory of Hygiene. The field work was done by the city of Madison. G. W. Filson, city lake inspector, was in charge of administering the copper sulphate and removing the weeds. E. E. Parker, city engineer, and J. Mackin from time to time contributed engineering advice in carrying out this project on such a large scale.

Unusual Alkali Soils in Southern Illinois

Through soil studies carried on co-operatively by the U. S. Department of Agriculture and the University of Illinois, a wide distribution of certain "alkali" soils has been discovered in the southern part of Illinois, which affect the type of crops that can be grown in these areas. These soils are similar to the "Szik" soils of Hungary, the "Solonetz" soils of Russia, and the "Slick spots," which occur in regions of low rainfall in the United States. These peculiar soils owe their distinguishing characteristics to the presence of certain salts which are common in the dry regions of the West, but which were not known to exist so far east as southern Illinois.

High Strength Concrete Versus Compressive Reinforcement

Comparative Design of Precast Railway Bridge Shows Economy in Precautions in Improving Concrete

By M. Hirschthal
Concrete Engineer, Delaware, Lackawanna & Western R.R., Hoboken, N. J.

In *Engineering News-Record*, Feb. 25, 1926, p. 332, the writer described the design of a reinforced-concrete bridge in which precast members were used for the floor and compressive reinforcement was introduced to supply the deficiency of available slab depth. Could this deficiency have been more economically made up by the use of higher strength or richer concrete? Recent experiments both in the laboratory and on the job have shown that, with proper care and supervision, a 3,500-lb. or 4,000-lb. concrete can be produced just as well as 2,000- and 2,500-lb. concrete. While the question at the present stage of this development in railroad bridge design is largely academic it struck the writer that economy of such a design as compared with that of one making use of additional reinforcement would be of interest and the following are the resulting figures and conclusions.

Let us assume a 4,000-lb. laboratory concrete or its resulting 3,500-lb. field concrete. Based on a coefficient of 0.325 as safe working stress, which is present-day common practice and which is conservative when compared with the Joint Committee specifications, we have a working stress of 1,137½ lb. per sq.in. The modulus of elasticity of this concrete may be assumed as one-tenth of that of steel as against one-fifteenth in the leaner mixtures. With these values, for n, f_s and f_c and with $f_s = 16{,}000$, the neutral axis would be located at a distance $X = 0.4155d$ from the top or compressive extreme fiber. By substituting this value of X, the percentage of reinforcement which produces stresses of 16,000 lb. per sq.in. in the steel in tension and 1,137½ lb. per sq.in. extreme fiber in compression is found from the equation,

$$p = \frac{1{,}137\frac{1}{2}}{16{,}000} \times \frac{0.4155}{2} = 0.01477$$

The formula for resisting moment for the above conditions is then

$$M_R = 16{,}000 \times 0.01477 \ \frac{(1 - 0.04155)}{3} \ bd^2 = 203.6bd^2$$

We may now proceed with the design of the slab units. The maximum moment (per lineal foot of slab) for which the slab under the Greenwood Lake Branch of the Erie R.R. described was designed is

$$M = 307{,}600 \text{ ft.-lb.} = 3{,}691{,}200 \text{ in.-lb.}$$
$$= 203.6bd^2$$

from which

$d = 38.85$ in. to center of gravity of steel reinforcement, which being in two layers would require somewhat over 4 in additional or 43 in. as total depth of slab, as against 45 in. for the slab as actually built.

This would indicate a saving of 2 in. in the depth of the slab and hence of ballast or fill adjacent to the

bridge on either side, but this would not be a fair comparison because the slab actually used on the bridge in question could readily have been reduced 2 in. in thickness by the addition of increased compressive and of course tensile reinforcement. Let us then figure the slab of the higher strength concrete for a depth of 45 in. as a comparison with the slab which is actually used.

For a total depth of 45 in. the moment given above, 3,691,200 in.-lb., would require four 1¼-in. square bars per foot of width of slab, or almost identically the amount required for tensile reinforcement in the case of the slabs actually used. We have now arrived at a basis of comparison for the two types of design.

For the concrete used in the actual slab, which would be classed as a 2,500-lb. laboratory or 2,000-lb. field concrete, with a cement-water ratio giving a 4-in. slump, the proportions of materials required are 1.39 bbl. cement, 0.37 cu.yd. sand, and 0.72 cu.yd. stone. Assume an average price of these materials obtaining in railroad work during the last year of $2.50 per bbl. of cement, $1 per cu.yd. of sand and $1.75 for broken stone, with reinforcing steel at 7½c. per pound in place. The volume of concrete in each unit is 41.7 ft. × 4 ft. 8 in. × 3 ft. 9 in. = 729.8 cu.ft. = 27 cu.yd.

The cost per cubic yard of the lower strength concrete based on these prices (for materials only) would be:

1.39 bbl. cement at $2.50 per bbl. =	$3.475
0.37 cu.yd. sand at $1.00 per cu.yd. =	0.370
0.72 cu.yd. stone at $1.75 per cu.yd. =	1.260
Total, per cubic yard.....	$5.105

For 4 ft. 8 in. unit width used on this bridge, the cost per unit would be 27 cu.yd. at $5.105 = $138.08 for concrete materials.

The amount of reinforcing steel used as compressive reinforcement in a 4-ft. 8-in. unit is

7—1¾ in. square bars 20 ft. long =	140 lin.ft.
5—1¾ in. square bars 28 ft. long =	140 lin.ft.
2—1¾ in. square bars 41 ft. long =	82 lin.ft.
Total	362 lin.ft.

Three hundred sixty-two lineal feet at $5.313 = 1,923 lb. as total weight of compressive reinforcement per unit, which at 7½c. per pound = $144.22. This added to the $138.08 for the concrete gives a total of $282.30 per unit.

Against this is to be balanced the cost of materials of the concrete of the higher strength, the proportions for which based on a 4,000-lb. laboratory or 3,500-lb. field concrete are 2.43 bbl. of cement to 0.25 cu.yd. of and and 0.68 cu.yd. of stone. Using these quantities with the prices as above the cost per cubic yard for this concrete would be

2.43 bbls. cement at $2.50 per bbl. =	$6.075
0.25 cu.yd. sand at $1.00 per cu.yd. =	0.250
0.68 cu.yd. stone at $1.75 per cu.yd. =	1.190
Total, per cubic yard.....	$8.515

The resulting cost of a corresponding 4-ft. 8-in. width of unit 27 cu.yd. at $8.515 = $202.90 for concrete material. Inasmuch as there is no compressive reinforcement in this design and the tensile reinforcement being practically identical in the two instances, only the cost of the concrete need be included. It is also assumed that it will cost no more to place this class of concrete because balanced against this is the plane of compressive reinforcement in the first case which adds to the difficulty and hence the cost of placing the concrete.

Under these conditions the saving in favor of the higher strength concrete would be $79.40 for a 4-ft. 8-in. width or $17.01 per foot width of bridge. For a two-track bridge this would amount to $561.33; for one of three tracks, $782,46; while for a four-track structure a saving of $1,003.59 would result.

This leaves little doubt of the economy in designing and specifying high strength concrete for slabs or beams. The case for columns is considerably stronger since the stress allowed in the steel reinforcement is directly proportional to the stress allowed in the concrete in compression, thus resulting in an economy of both concrete and steel, and at the same time permitting the use of smaller columns and greater available floor space.

The difficulty is that of educating a sufficient number of contractors to the necessary care in proportioning, etc., to produce such concrete to permit obtaining competitive bids on a specification calling for these conditions. While there are a few such contractors in this vicinity, it is feared that there are not enough at the present time to make a quorum for bidding on bridges so designed and specified. However, there is no doubt in the mind of the writer that, ere long, designs of this character will not be at all unusual.

New Tests for Concrete Workability

STUDIES of the workability of concrete being made at the Bureau of Standards under a co-operative research arrangement with the Celite Products Co., Los Angeles, Calif., are reported as follows in the "Technical News Bulletin" of the Bureau:

The purpose of this work is to devise an apparatus which will measure accurately that quality of concrete known as workability and to obtain this measurement in units which are used in engineering work. Several years ago a penetration apparatus was developed in the cement section of the bureau for the measurement of workability. The apparatus consisted of a 6 x 12 in. cylindrical mold mounted upon a small table which can be raised or dropped about one-tenth inch by means of a cam. A spider carrying a sleeve is mounted on the top of the mold. Through the sleeve a close-fitting rod is introduced in alignment with the axis of the mold.

The batch of concrete to be tested is placed uniformly in the mold and first compacted by 30 drops of the table, then the rod is inserted in the sleeve and lowered gently into the concrete until it comes to rest under its own weight. The cam shaft is then turned and the mold full of concrete is successively raised and dropped in such a manner as to allow a reading of the penetration of the rod after each impact. The test was regarded as completed when the rod had penetrated the concrete 10 inches.

As the same means were used for driving the rod through the mass as were used for compacting it, the test was not reliable for the lean and harsh working mixtures. To overcome this objection and to secure more exact measurements on all mixtures a new method has been devised for driving the rod. The new part of the apparatus is similar to a pile driver in that a weight is released from a fixed height above the rod and falling free drives the rod through the concrete without further raising and lowering of the table, once the concrete is uniformly compacted. The workability is measured by the reciprocal of the work in causing the penetration of the rod.

The Civil Engineer in Industry

—AN EDITORIAL SURVEY—

IV. Industrial Municipal Engineers

The Last of Four Articles Reporting the Results of a Study Into a Little Appreciated Field of Civil Engineering

IT FREQUENTLY happens that an industry, in its infancy, locates in practically virgin territory. In such instances, proximity to labor markets, transportation and raw materials are the dominant factors in the selection of a site. If the industry attains any size, sooner or later it is necessary or advisable, at least, to carry on a type of engineering work which closely approximates that performed by the city engineer in a small municipality. In the study which *Engineering News-Record* has undertaken of the civil engineer's part in industrial manufacturing, two outstanding examples of this type of community have been observed. These are the Hershey Chocolate Company's community at Hershey, Pa., and that of the Endicott-Johnson Shoe Co. at Endicott, N. Y.

Hershey Chocolate Co.

About 1905, after the Hershey Chocolate Co. had been operating for a number of years at Lancaster, Pa., M. S. Hershey, the founder and the owner of the business, decided to move it root and branch (the present buildings cover some 45 acres) to Derry Church, Pa., now the site of Hershey, a town devoted exclusively to the manufacture of chocolate products, built in a rolling, rich, agricultural valley, 14 miles east of Harrisburg, Pa. At the time of moving the business to Dauphin County, Mr. Hershey called from a consulting civil engineering practice in Lancaster H. N. Herr, who was put in charge of all civil engineering work in connection with the expansion of the company's community, which was rapidly building up and which was served only by the then meager facilities which the company and the times were able to provide. Mr. Herr has been there since and his office now resembles that of a city engineer in a municipality of around 25,000 inhabitants.

Municipal services which he has assisted in developing are the Hershey Transit Co., which operates between 30 and 40 miles of suburban railway; the Hershey Electric Co., which provides power and light for the community and adjacent territory; the Hershey Water Co. and the Hershey Bell Telephone Co. Mr. Herr has charge of civil engineering in connection with the development of the town and is general manager of the electric, water and telephone companies and is chief engineer of the transit company. He also has charge of the outside engineering work in connection with the plant itself, though no control over the design of new manufacturing units, and has considerable to do in an advisory capacity with the Cuban developments. The engineering work in Cuba concerning which his advice is sought has to do with the provision of transportation service for what was originally four sugar mills with a capacity of approximately 800,000 bags. In order to get the cane from the plantations to the mills, approximately 125 miles of railroad were built, of which considerably more than half is now public service.

Although Mr. Herr joined the staff of the Hershey Chocolate Co. in 1905 when the company began laying out the town—which is entirely unincorporated and merely a part of the township—and building electric railway lines to the adjacent boroughs and towns as a solution of the immediate labor problem, the greatest development in the business and town proper has taken place in the last ten years.

In order best to understand the ramifications of Mr. Herr's activities it is perhaps easiest to follow him through a day's work. When one goes into his office, which is in the main manufacturing building, there are evident all of the personnel and equipment of a city engineer's office. There is one draftsman working on the plans for a sewage-disposal plant, and another figuring yardages on new street improvement work. There are half a dozen men at work in the office, or getting ready to go out on the job, which may take them to any section of the widespread unincorporated town. The work may be concerned with maintenance work on the 40 miles of electric railway, repairs and improvements on the 10 miles of private streets and roads,

extensions of sanitary or storm sewers, laying out and installing water mains, electric power lines and service lines, location and grades for new buildings and extensions and improvements in park development (as a portion of the 10,000 acres owned by the company is devoted to parks) and recreational grounds and structures.

Mr. Herr will take you first to the company park, in

which have been placed numerous recreational facilities, practically all of which with the exception of one or two concessions are entirely maintained by the company. We have here an auditorium seating thousands of persons and which was designed originally to take care of either a grand opera troupe or a stock show, athletic grounds, a small grandstand, swimming pool and playground laid out all in a general way under his directions. Driving through the park one sees a footbridge over a ravine built of reinforced concrete which, it is explained, also carries the sewage to the disposal plant. It happened that the best grade and line to the disposal plant cut through the park, so Mr. Herr designed a box sewer that would serve this double purpose.

Driving on a little farther one comes to the rock crushing plant and quarry where most of the road material that is used on the 10 miles of private streets is prepared. It is a quarry and crusher erected and operated by company forces under Mr. Herr's direction. If one covers the major mileage of streets there are encountered mostly asphaltic concrete and crushed stone metal surfaces.

Leaving the outskirts of this industrial village, where incidentally everything appears to have been swept clean with a gigantic broom, one passes over miles of country roads winding through the various farms which the company maintains. As a succession of wooded hills is passed the car stops and Mr. Herr indicates with a sweep of his arm where he is going to install an 18-hole golf course for the use of the employees of the company. Below you a thick growth of pine fringes the otherwise grass or flower grown hillsides. Mr. Herr explains that it is part of a carefully worked out forestation program which the company has embarked upon. Closer inspection reveals a wide variety of trees and shrubs and all this is included in the forestation work.

Upon the highest hill ahead from which the picturesque country unfolds in front of you, have been built two reservoirs for furnishing a gravity water-supply to the village. The supply is taken from a nearby creek, filtered and stored in two 1-m.g. reservoirs and fed into mains, giving an average head of 200 ft. Mr. Herr explains that a nominal charge is made for water, the charge being based on the average per capita consumption for the previous five-year period, construction and maintenance costs of the plant being the considerations involved in the charges made.

Leaving this highest hill one again seeks the lowlands, soon arriving at a sewage-disposal plant which Mr. Herr has designed and built himself, and which, incidentally, was chosen as one of the model small plants to be exhibited, in replica, at the Sesqui-Centennial Exposition at Philadelphia the past summer. The entire sewerage system is gravity and the sewage is all treated at the single plant which has been designed to care for a much larger population than Hershey now possesses. The sludge is granulated and used in the neighborhood for fertilizer. The main outfall to the treatment plant has been laid to parallel a creek, which, if necessary, can be inducted into the outfall to be used as flush water. An 1,800-ft. effluent line leads from the treatment plant again to the creek below. This line has a capacity of 2½ sec.-ft.

On the return to the office Mr. Herr shows you the reconstruction work going on at the company inn, which is partly under his direction. You pass school houses which he has helped to construct and he stops to give directions to some workmen who are building the foundations for a series of buildings that are to form the industrial school for orphan boys which Mr. Hershey is having built. However, much of the superstructure construction is now under the direction of a young

architect whom Mr. Hershey has hired, and all of the materials are supplied by the Hershey Lumber Co.

Thus one finds that Mr. Herr, in common with many other engineers holding like positions, has under his direction, not only in design and construction, but operation, all of the services coming under the supervision of the city engineer in the small municipality, and in addition superintends many other details which only a community such as the one which he serves imposes.

Endicott-Johnson Shoe Co.

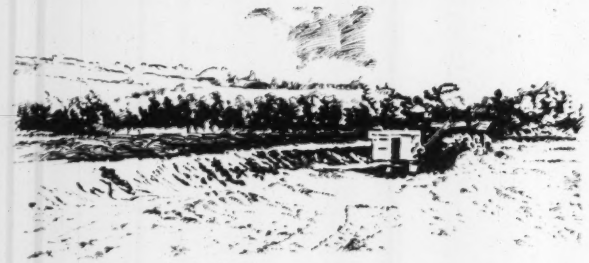
In the communities which the Endicott-Johnson Snoe Co. has built up at and near Endicott, N. Y., there is found much the same engineering services as that administered at Hershey. Here too the engineer supervises engineering work on company property alone; the town in which the main plant is located is incorporated and has a city engineer. Although M. H. Boigeol, the civil engineer in charge of the civil engineering work at the Endicott-Johnson properties, has multifarious duties both in connection with the plant itself and company communities, the building of housing projects and the general improvement of physical and topographical features of company property consumes most of his time

Mr. Boigeol supervises no labor directly but advises and assists the various departments upon request. The various branches of the mechanical department, under which his office is organized, operate as though each was a business in itself. When its services are required it is called upon, thereby furnishing immediate, adequate and inexpensive service in the various lines.

When the shoe company started upon any extensive housing work it built the houses to rent. Latterly all houses have been constructed to sell to workmen when

they have demonstrated they are responsible. The average priced house now built sells in the neighborhood of $3,000. Such a house will have seven rooms with bath, hardwood floors, cement cellar with laundry and complete heating system, electric lights, plumbing, a large lot fully graded, and served with sidewalks, sewers and water. It is such houses, with appurtenances, that have engaged the major attention of Mr. Boigeol for many months. In their construction, though Mr. Boigeol has, in conjunction with Frank I. Johnson, planned the developments, streets, sewers, etc., the actual building and direct supervision of labor has been Mr. Johnson's responsibility.

Though the town of Endicott is incorporated, and has its engineering services administered by a city engineer, the community of West Endicott, still all company property, and almost all of which has been constructed during the past five years under Mr. Boigeol's supervision, is the "small city" Mr. Boigeol serves as "city engineer." During his tenure the corporation has built and sold to workers at cost 460 houses. Among engineering services installed have been 28,500 ft. of 8-in. sewer, 4,380 ft. of 24-in. sewer in the Endicott housing situation; and 15,250 ft. of 48-in. sewer, 5,000 ft. of 24-in. sewer, and 200 ft. of 18 and 12-in. and 2,200 ft. of 8-in. sewer around the Endicott plants. This is strictly corporation-owned and maintained, the village system being entirely separate from the plant system. Both garbage and ash collection systems are maintained by the corporation for the benefit of the village.



Mr. Boigeol also has numerous problems of an engineering character to solve at the factory itself. Endicott has the largest tanneries in the world, made up of a series of six buildings. The sole leather tannery, alone, has 14 acres of floor space. The upper leather tannery annex is a six-story, reinforced-concrete building 100 ft. x 200 ft., one half of which was built by company forces in 1923. Line drawings were sent to the Steel Bar Co. which firm designed the building. Mr. Boigeol laid out the building and superintended erection in accordance with the designs, inspected materials and, in general inspection, saw that the work was properly executed. Having thus supervised construction of the building, one of his jobs was to maintain it, so not long ago when one of the bearing walls subsided to such an extent that the curing vats contiguous to the wall became seriously affected, Mr. Boigeol devised means of strengthening. He made observations over a period of several weeks as to what the rate of subsidence was, excavated where the subsidence was centered, jacked up the building, and when subsidence had been observed to end, reinforced the wall by putting in new footings. Operation of the plant was not interfered with and the company was spared the expense of extensive reconstruction work.

Incidental details of a civil engineering nature are not without Mr. Boigeol's superintendence. Shortly after joining the company he noticed a millwright trying to align a drive shaft with a carpenter's level. Mr. Boigeol got his transit, established line and grade and saved the millwright half a day's work. At another time some workmen started to move a heavy machine across an overhead bridge from one shop to another without reinforcing the bridge which obviously had been constructed primarily as a walkway. Mr. Boigeol stopped the workmen before they had got far. Without such assistance (he merely laid a couple of heavy I-Beams down as a runway) an expensive machine would undoubtedly have been heavily damaged and reconstruction of the bridge would have been necessary

Aside from his miscellaneous small duties of an engineering character in and around the plant he has had to install water facilities and those for waste disposal. Consulting advice was sought, however, when it became necessary to design a special plant for the treatment of industrial wastes from the curing vats. In effect it is a sewage treatment plant with trash racks for the recovery of fats and hair that otherwise would make sewer cleaning an endless problem.

The water-works plant is equipped to pump either by air-lift or electric pumps. The wells are located near the north shore of the Susquehanna River and have an average depth of 150 ft. There are 21 wells operated by air lift and four 12-in. wells equipped with individual coniflow deep-well, direct-connected pumps, with a capacity each of 1,200 g.p.m. The water is pumped directly into fifteen miles of pipe, the surplus going to three steel tanks, two miles from the wells. The tanks are on a hill above the tanneries and are 94 ft. in diameter and 30 ft. high, each of 1,500,000-gal capacity. The tanks are equipped with level indicators registering at the pump station. Gallons pumped during 1925 equalled nearly two billion.

The water-works, which is a subsidiary of the Endicott-Johnson Corporation, supplies the village as well as the corporation needs. It is directly supervised by Earl Grippen. Duties of Mr. Boigeol here are the same as in other departments—to advise on installations, extensions of lines, etc.

The corporation also develops its own electric power, having about 5 miles of high-tension line carried on steel towers.

In addition to these various responsibilities Mr. Boigeol has parks and playgrounds to construct, roads to build and maintain, and special building construction, such as a hospital, school buildings, fire halls, etc., to supervise.

In the study which *Engineering News-Record* has undertaken of civil engineering in industrial plants, for this particular type of engineering service but two outstanding plants have been selected. Investigations which this journal carried on both by visits to the plants themselves and by means of correspondence showed there to be many more. But these are typical. In such plants the civil engineer designs, constructs and operates. The services which he has under his control are innumerable, and in their construction and operation the civil engineer is looked to do the thing himself, purchasing, or recommending for purchase, his materials where he needs them, whether that equipment be a bundle of laths or a road roller. That is his job and he is given practically a free hand in the accomplishment of it.

Technical and Statistical Problems Under Study by Highway Research Board

Sixth Annual Meeting Pictures Extensive Activities—Pavement and Subgrade as Well as Volume and Safety of Traffic Are Principal Subjects of Investigation—Current Practice Surveyed

FOUR busy sessions constituted the sixth annual meeting of the Highway Research Board held last week at Washington. This joint board now comprises 24 technical and other organizations interested in bringing together at one reporting point all current activities in the study of highway problems. It acts mainly through standing committees, but in addition reports and to some extent directs other investigations. The registration reached 300.

Seven committees reported, on subjects ranging from finance and traffic analysis to road location and structural problems. Two current investigations also were the subjects of reports. Only part of the work reported was of strictly research character, other parts being the compilation of current practice and statistical study.

Thomas H. MacDonald, chief of the Bureau of Public Roads, gave an address reviewing some European road conditions and stating his belief in the essential fallacy of building roads for the long distant future, as against the greater value of building for present requirements.

At the opening session, which included addresses by Prof. A. N. Johnson, chairman; C. M. Upham, director, and Vernon Kellogg, of the National Research Council, only two technical items were presented: a statement on research work in the road and automobile fields now going on at the Bureau of Standards and a report on highway accidents. The other three sessions of the meeting were solidly devoted to technical matters. The following committees reported: Economic theory of highway improvement, structural design of roads, character and use of road materials, highway traffic analysis, highway finance, and maintenance. Separate investigation reports dealt with study of culvert service and with low-cost improved roads. In addition there was an interesting and stimulative paper by Dr. Charles Terzaghi on "Methods and Possibilities of Road Soil Investigation."

Bureau of Standards Work—Dr. George K. Burgess, director of the Bureau of Standards, laid stress on the need for uniformity of cement throughout the country, and mentioned the investigation of this material now in progress at the bureau by a research fellow maintained by the cement interests. Both normal and high alumina cements will be included in the investigation. Extensive studies of tire durability, wear and power loss have been carried out and are still progressing. Brake efficiency has been given much attention and about 1,000 accelerometers are now in regular road service to develop further working data. Skidding has been studied by models. Headlighting is becoming a most important subject, especially as it is not clear whether present laws are adequate or whether their enforcement is weak; in this matter the bureau is working with the Society of Automotive Engineers and the Illuminating Engineering Society. Visibility of traffic signals and some of the factors bearing on the legibility of illuminated license plates have been developed.

Highway Accidents—Dr. H. C. Dickinson, in a preliminary statement for the newly formed committee on Causes and Prevention of Highway Accidents, pointed out the relative infrequency of automobile accidents, the average expectancy at the present time being only one fatality in 1,000 automobile years, or five or six million vehicle miles. Of these accidents, seven-eighths are attributable to personal causation, nearly 70 per cent of these being caused by operators and 30 per cent by non-operators, while only 10 or 12 per cent are due to causes residing in either the vehicle or the highway. Highway factors that invite study of the committee are such as causes of skidding, curve transition, superelevation, blind crossings or curves, blind spots in vehicles, bad headlighting, and the like. It also seems necessary to study the psychological effect of traffic laws on drivers, for if certain laws have the effect of making worse the conditions which they are intended to correct, it may be desirable to revise these laws.

In discussion, E. L. Clarke (Clemson College) dealt with the problem of keeping drivers on their own side, and advocated a rough cobble center strip between side pavements. Prof. C. J. Tilden (Yale University) stated that the multiplication of light signals, and particularly the use of three-light signals, is in many instances producing dangerous conditions and suggested using a red light only. Dr. L. I. Hewes, of the Bureau of Public Roads, described a fatal accident which occurred on the Rogue River road in Oregon last summer, partly caused by a bridge approach of 100-ft. radius following a long tangent, and suggested that conditions of this kind should be avoided in construction. Doctor Dickinson finally stated that skidding and coefficients of friction will be an excellent beginning of research work.

Location—Prof. T. R. Agg (Iowa State College), for the committee on Economic Theory of Highway Improvement, which is concerned with location problems, reported very briefly on tire wear studies, tractive resistance, wind resistance, and studies of side skidding friction. Tire wear studies by Prof. O. L. Waller (State College of Washington) were extended this year to soft tires. It has been found that tire wear increases with speed and with temperature, that rear tires wear from slightly more to twice as much as front tires, and that on various pavements, for normal loading and inflation pressure, the relative amounts of tire wear represent useful mileages of more than 20,000 for the best pavements and to as low as 2,000 for the worst. Relative wear is as follows:

Concrete	1.0	Average macadam	4.4
Bitulithic	0.95	Gravel, uncrushed chert	5.0
Brick, average	1.4	Bituminous macadam, poor	9.6
Macadam, best	1.9	Macadam, loose	11.0
Gravel, typical Iowa	2.0		
Bituminous macadam, best	2.3		

Rolling resistance and other elements of power consumption are being studied at North Carolina State

College by Prof. H. B. Shaw, using a gasoline-electric test truck in which speed and torque are measured. Test runs with this truck, of which several have been built, indicate that the tractive effort formula comprises a constant for displacement and a term for air resistance in which the velocity has an exponent of 2.14. An additional term, representing impact, is negligible. Discussion by W. L. Holt and P. L. Wormeley (Bureau of Standards) suggested that fuller study of the results might bring the exponent for wind resistance down to the more commonly accepted 2.

Studies at Iowa State College have shown that roughness of road surface, while it increases rolling resistance at lower speeds, may decrease it at high speeds. Experiments showed side-skidding friction to lie usually between 0.625 and 0.925, but when the road is covered with snow and ice or with oily slime or mud, the friction may drop to one-fourth of these figures.

Structural Design—In addition to the pavement and surface studies of the committee on Structural Design (chairman, A. T. Goldbeck), subgrade or soil studies have come into an important position. Prof. F. H. Eno (Ohio State University) is carrying on extensive investigative work on vertical displacement of pavements due to moisture changes in the subgrade, on moisture content, on the effect of porous subbases, and on tests for soil characteristics. A statistical study of pavements to correlate pavement condition and service with nature of subgrade is being conducted by C. A. Hogentogler (Bureau of Public Roads). V. R. Burton (Michigan State Highway Department) has made elaborate studies of the behavior of earth fills on peat to determine behavior and proper construction.

Professor Eno finds that pavement displacement seems to have no relation to the mechanical analysis of the subgrade soils, but increases with capillarity of the soil. He has measured vertical displacements of pavement ranging from 0.025 to 0.265. He infers that an unreinforced concrete pavement is likely to break more and more each successive year as the result of such displacement. The movement may be quite rapid, a 0.2-ft. difference of elevation occurring in 18 days. Measurements of subgrade moisture content were reported, for different depths. The badness of particular subgrades was not found to be properly indicated by the Atterberg limits; the lower liquid limit was found to have the greatest significance. The slaking test appeared to be of some value, but it must be carried out under precisely regulated conditions. As a tentative classification, using 1,200 lb. pressure, air dry samples, and a uniform temperature of slaking water, Professor Eno suggests slaking in 20 min. as indicating a very dangerous soil, 20 to 30 min. questionable, 30 to 50 min. fair, and over 50 min. excellent soil.

Various porous subbases tested on a stretch of road showed that with pavement on the natural soil the length of crack per foot of road was 1.29 ft., while various subbases reduced the length of crack to amounts ranging from 0.45 to 1.12 ft., the higher values being for lean concrete subbase and the lower values for slag, sand, and gravel.

The Michigan studies of fills on peat marshes indicated that with shallow marsh it is advisable to excavate the soft ground before depositing fill materials; with deeper soil, to deposit two parallel embankments confining a certain amount of soft material between them and bridging the main body of the road subgrade across these embankments; and for very deep peat, to deposit a narrow embankment and force it down as rapidly as possible to the bottom, compressing the peat toward either side and forming a relatively narrow stem to support the embankment. It was found from many borings through embankments on peat that with peat more than 26 ft. deep the fill always penetrated through its whole depth to the hard bottom below.

Statistical studies of the relation of pavement conditions to subgrades will be carried on by Mr. Hogentogler on the basis of a subgrade soil classification being worked out by Dr. Charles Terzaghi.

Pavement Surfaces—A brief report was made on the truck tests on brick pavements 2 in. and 2½ in. thick, reported a few months ago. Bituminous road construction was reported upon by G. H. Henderson, chief engineer of the Rhode Island Highway Commission, who emphasized the necessity for conscientious care in each step of the construction and asserted that it is impossible to overroll bituminous macadam pavements.

Concrete pavement tests in progress at Arlington were briefly reported by J. T. Pauls (Bureau of Public Roads). Forty 24-in. strips 200 ft. long have been laid, under various curing methods, admixtures and surface treatments, with a view to observing the incidence of surface checking and shrinkage and contraction cracking. Prof. H. M. Westergaard (University of Illinois) has carried out a mathematical analysis of curling stresses of a concrete slab on elastic supports. One of his results is that in a half-width slab the temperature or curling stress is slightly less than half as large as in a full-width slab.

Reports on the value of planes of weakness in concrete slabs and on the effect of mesh reinforcement upon the extensibility of concrete were presented by C. N. Conner, formerly of the North Carolina Highway Commission, and Prof. W. K: Hatt, of Purdue University. In the North Carolina test road, a 2,000-ft. length with a plane of weakness every 40 ft. showed only one transverse crack and no longitudinal cracks, whereas two 800-ft. adjoining sections without planes of weakness and with construction joints only at the end of the day's or half day's work had 15 to 30 transverse cracks each.

J. C. Albright briefly sketched the experimental concrete road now under construction by the State of Virginia near Bull Run, comprising 45 test sections 18 ft. wide.

Impact—Some results on motor-truck impact measurement were given by J. A. Buchanan (Bureau of Public Roads). With solid tires it is found that the unsprung weight is responsible for 90 per cent of the total impact at speeds over 6 m.p.h. The impact under six-wheel trucks is only about one-half that under four-wheel trucks.

Road Materials—A compilation of current practice on use and control of quality of road materials was presented by the committee headed by H. S. Mattimore, of the Pennsylvania Highway Department. It summarized present information on the effect of alkali on concrete, experience with the freezing-and-thawing, the sodium sulphate and the sodium chloride tests, field control of concrete, and commented on transverse beam tests and bituminous mixtures for surface treatment.

On alkali, the chief statement was that carefully made, well cured concrete rich in cement and of high strength

and low permeability resists alkali attack most effectively; that admixtures, as a rule, have not proved beneficial; that different cements differ markedly in their resistance; and that surface coatings appear to have some possibilities. Some cements were found to be particularly low in alkali resistance.

Discussing these reports, Duff A. Abrams (Portland Cement Association) reasserted that the manufacture of concrete is the solely important element. In his tests, under natural exposure, he has found that concrete which gives the highest 28-day strength also shows the greatest resistance to strong sulphate water in five to six years of exposure. Three coats of boiled linseed oil gave concrete perfect protection in a 5-year exposure.

Maintenance—The report of the maintenance committee, by W. H. Root (Iowa Highway Commission), dealt at some length with snow clearing, and asserted that road users are coming to demand winter maintenance very generally. The report stated that the user pays for winter maintenance whether he gets it or not. During the winter of 1925-26, snow clearing was done on 93,000 miles of highway at a cost of about $40 per mile. Plows of the straight-blade and V types are used for clearing and heavier tractor plows and rotary plows for opening roads. Much use is made of snow fences. On the subject of maintenance and repair of concrete pavements, it was held that maintenance work should be done with a quick-setting concrete made by using a rich mixture of minimum water content, thoroughly mixed and with calcium chloride added. Bituminous materials can be used if concrete is impracticable.

Figures from Indiana were reported to show that the annual wear of untreated gravel roads averaged 0.289 cu.yd. per mile for a traffic of one vehicle per day.

Criticisms of the report by J. N. Mackall (Maryland Highway Commission) attacked the proposal to use ordinary cement for repairs to be opened to traffic in one or two days and insisted on the use of special quick-setting cement. He also remarked that he is prepared to show excellent results in resurfacing concrete roads with bituminous mixtures. Mr. Mackall also called for more complete collection of snow removal figures and their analysis to supply a real demonstration of the necessity of keeping roads open. The wear figure of gravel roads he characterized as valueless.

Culvert Studies—In the study of culvert service, under Prof. R. W. Crum (Iowa State College), a method of culvert rating has been developed in tentative form, after inspection of 500 culverts in 14 states. The basis of the work is the fact that small culverts do not get the best of attention in design or construction and that it remains a problem to determine the specific conditions suitable for the different types. For the present, the system of rating is still considered uncertain, and even more so the numerical interpretation of the ratings.

In discussion, Prof. G. M. Braune (University of North Carolina) gave a description of the measurement of vertical pressures on culverts under high fills (up to 20 ft.), which is the subject of tests at Chapel Hill, and O. H. Hansard (Tennessee Highway Department) made various criticisms of the rating form worked out by the investigating committee.

Highway Traffic Analysis—The principal function of highway transportation surveys, said the committee on highway traffic analysis, headed by G. E. Hamlin (Connecticut Highway Commission), is (1) to measure present and predict future volume and character of road traffic; (2) to determine the relationship between population and demand for highway service, and (3) to classify highway routes or sections of routes. The committee also brought out that long hauls by large vehicles are rare and the extra expense of building pavements wide enough for these vehicles is not justified.

Highway Finance—Reporting on finance, Prof. H. R. Trumbower (University of Wisconsin) gave a mass of data on sources of highway funds. One interesting item of the figures showed that 67 per cent of the net gasoline tax collections is devoted to the construction and maintenance of state highway systems, 22 per cent is diverted to local highway use, and 4 per cent is used to meet highway bond requirements; and that 89 per cent of the gasoline tax and 91 per cent of license fees are used for construction and maintenance of highways (state and local). These data are from 28 states, in which the gasoline tax furnished 12 per cent of the state highway funds. State and local authorities together in 1925 spent for rural highway purposes the sum of $1,288,000,000.

Road Soil Investigations—Dr. Charles Terzaghi (Massachusetts Institute of Technology) presented an interesting paper outlining some conclusions derived from studies of soil physics and physical properties, as to basic measurement factors related to service value of the road subgrade. The physical factors most readily available for measurement are compressibility, elasticity, shrinkage on drying, expansion on wetting, and permeability. Independent study of each factor reveals that compression and elasticity are the most elementary of these phenomena, and both are of the most direct service in gaging soil behavior.

Dr. C. F. Marbut, of the U. S. Bureau of Soils, pointed out in discussion that four different soil groups are apt to be involved in the road maker's work, the A layer, or surface layer modified by atmospheric agencies; the B layer, or clay layer; the X layer, a special modification of the B layer found in some isolated regions, showing a very high percentage of colloids of both organic and inorganic kind; and finally the G layer, or geologic layer. He gave the impression that measurement of soil qualities would necessarily be different for each of these separate horizons.

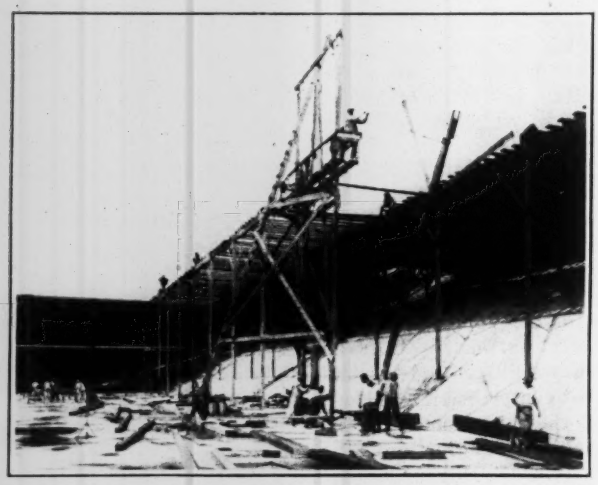
At the highway research dinner, held on the evening of Dec. 2, some pertinent points of interest were brought out in an address by Pyke Johnson, of the National Automobile Chamber of Commerce. Messages from various men prominent in the motor industry as well as his own summary emphasized city traffic complications as one primary subject requiring immediate study, although one of the motor leaders directed strongest attention to the problem of wider roads, with provision of bridges and grade crossings even wider than the road to allow for future increase of capacity. With reference to rural roads in general, Mr. Johnson asked what would be the effect of farm development brought about by primary roads, upon the secondary tertiary roads, and the subsequent problem of how we are to get more roads at lower cost. With respect to the problem of determining the relative fields of different transportation systems, he pictured the probable influence of motor-truck development upon railroads, allowing them to keep their freight systems out of the center of cities by utilizing motor-truck terminal haulage.

From Job and Office

HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Traveler Speeds Erection of Posts for Oil Reservoir Roof

IN THE construction of a 3,000,000-bbl. oil reservoir for the Southern Pacific Co. near Tracy, Calif., a timber roof was required over an area of 14 acres. The roof was to be supported on 6x6-in. posts, averaging about 32 ft. high, standing on the concrete floor. As part of the plan to speed up the job as much as possible, a traveler was used with which the roof posts were



TRAVELER ERECTING ROOF POSTS IN TRACY RESERVOIR
Note 7-ft. wood standard at left for supporting plumb bob. Two of these were used

erected and held in place while being fastened to the rafters. The traveler is shown in operation in the accompanying picture.

The traveler consists primarily of three supporting posts, two vertical and the third inclined, firmly braced and tied together so as to serve as a derrick for lifting and also to carry a working platform at a convenient height above the floor. The traveler was mounted on large rollers so that it could be rolled along as the work progressed. Cleats on the inclined posts were used by the workmen in lieu of a ladder.

Posts were delivered to the concrete floor of the reservoir where short lengths of 2-in. planks were nailed on either side at the top of each post to be ready for fastening to the girders that connected them. Before erection the bottom of the post was placed against one side of the concrete pedestal on which it was to be supported and thus a line to the top of the post could be used to up-end it. Power for lifting was provided by a hand winch, operated by four men at the bottom of the traveler. The rope was not removed until the post had been lifted and set on the concrete pedestal.

The post was temporarily held in an approximately vertical position while the 6x14-in. girder was raised bodily by the winch, set in place and spiked by the two men on the working platform. This exactly determined the proper position for the top of the post along the line followed by the girders. The position at right angles to that line was then fixed by extending a single rafter to the girder near the post and spiking it in place. After the top of the post had thus been fastened, plumb bobs on light 7-ft. frames were used to true up the bottom before driving the spikes that fastened it to the foot block. This method is reported far superior to the use of a dowel in the pedestal and a hole in the base of the post. That plan, even with the greatest care, was found to get roof posts out of plumb in a long run due to cumulative errors.

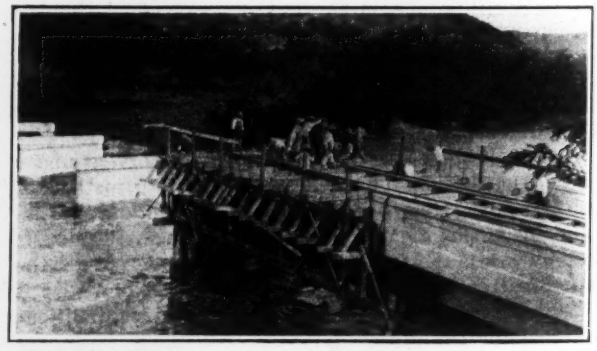
On the Tracy job the posts are spaced 20 ft. apart and with a crew of about ten men the erection of posts and placing the girders progressed at rates ranging up to 150 posts per 9-hr. Possibly a smaller crew could have been used if it were not for the number of men required to move the traveler.

The work was done by Southern Pacific Co. forces under the direction of W. H. Kirkbride, chief engineer maintenance-of-way and structures, and under the personal supervision of J. M. Evans, assistant engineer, Standard Oil Co., who was loaned to the Southern Pacific Co. expressly for this work.

Heavy I-Beams Support Formwork for Mexican Bridge

By P. K. Schuyler
Formerly Bridge Engineer, Mexican Federal Highway Commission. Now in U. S. Bureau of Public Roads, Washington, D. C.

DURING the highway construction program carried on by the Mexican government during the past year it was found necessary to build the superstructure of a reinforced-concrete deck girder bridge during the



NOVEL FORMS ON CONCRETE DECK GIRDER BRIDGE

rainy season. Due to the frequent high water and swift velocities in the Amacazac River it was not feasible to use the ordinary type of timber falsework and for the same reasons light steel trusses as supports for the forms required too much underclearance and would have been liable to loss, so the type of support shown in the photograph was used. This type required only some 2-ft. clearance below the top of the piers. The rapid rise or fall of the water can be noted from the marks on the piers in the photograph.

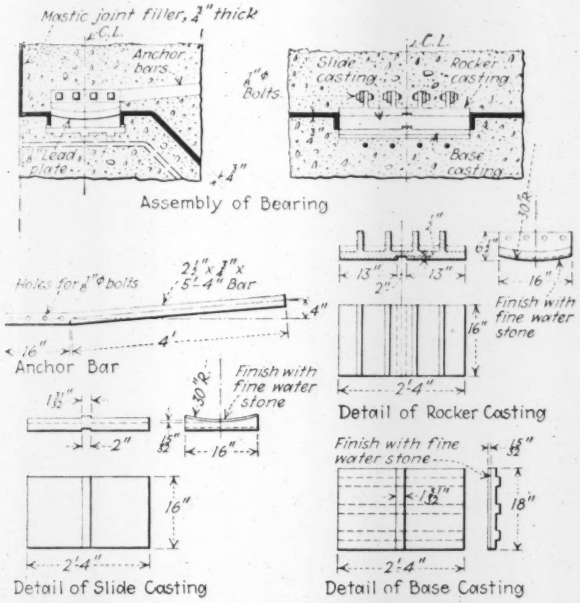
Four 30-in. I-beams were used to support the forms

of each 13-m. (about 40-ft.) span. These I-beams were removed from the grillage foundation of the unfinished legislative palace which was started in the days of the presidency of Diaz. Hangers were designed to clamp over the bottom flange of these beams and support the timber caps and on these caps the usual forms of timber were constructed. The I-beams and hangers were moved along from one span to another, two sets being used in the construction of the five-span bridge so as to save time.

The I-beams were obtained without any cost except freight and the 24 hangers required for each span cost about $200. These forms proved to be rapid in erecting and satisfactory in every way.

Steel Bearing Plates for Large Concrete Girders

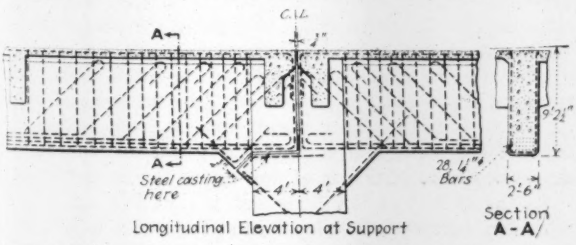
IN THE construction of the approach spans on the Ross Island bridge across the Willamette River at Portland, Ore., a series of reinforced-concrete girders



DETAILS OF STEEL ROCKER CASTING FOR CONCRETE GIRDERS

used on either side of the roadway have a depth of 9 ft., 2½ in., a width of 2½ ft., and a maximum length of 76 ft.; 72 ft. in the clear span. These girders support a roadway 38 ft. wide between curbs with a 5-ft. sidewalk on either side.

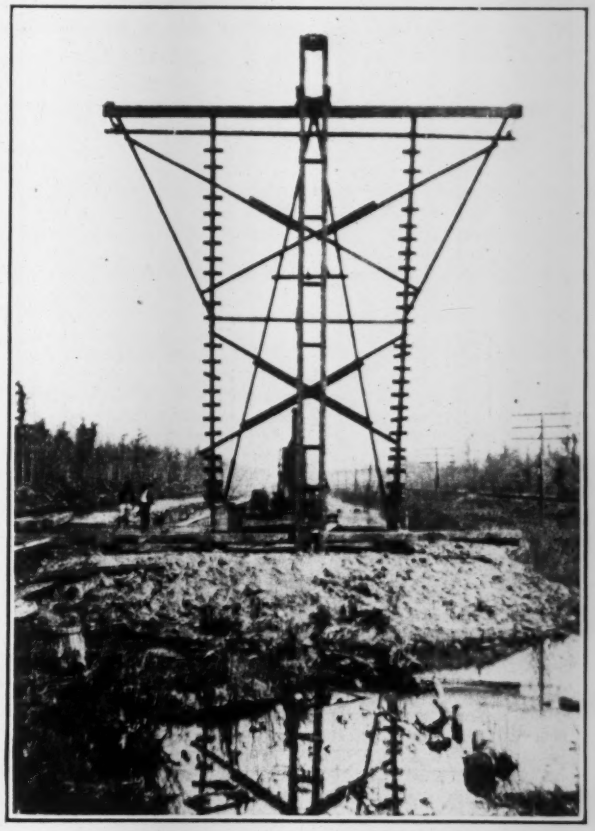
One end of each girder is fixed while the other end is supported on steel castings, shown in the accompanying drawing. These castings are designed to permit slight movement both in sliding and in deflection so that when such movements are caused by loading there need not be either crushing of the material or cracking. The castings consist of three separate parts fitted together on carefully machined and hand-finished surfaces. The bearing as a whole is encased in a graphite compound to make it as waterproof as possible.



SECTION OF CONCRETE GIRDER AND LONGITUDINAL ELEVATION AT JOINT

Piledriver Rig With Shifting Leads Builds 53 Trestles

TO DRIVE piles for 53 trestles aggregating nearly two miles in length on the new state highway between New Orleans and Hammond, La., 23 miles, it



TRAVERSING LEADS HUNG FROM 40-FT. CAP

was necessary to devise a rig that could be moved readily from place to place. The fill for the roadway was deposited by dredges floating in a canal or borrow-pit, openings being left for the bridges. This fill was mainly slush and was too soft to carry the piledriver rig in moving. The depth of water at the openings ranged from 1 to 25 ft. It was decided, therefore, to float the piledriver from place to place. A barge 80x26x6 ft. was procured, with a motor boat powerful enough to tow it, and with nine 12x12-in. skidding timbers 26 and 48 ft. long. On these timbers the piledriver was slid into position, so that it was set up over the first bent and ready to drive as soon as it was off the barge. The trestles had 5-pile bents, with all piles vertical; the end bents had two additional piles to hold the wings of the bulkheads.

To meet these conditions the piledriver rig shown in

the accompanying view was designed. It is of the "creeper" type, but with traveling leads. This rig consisted of two gunwales about 60 ft. long, well braced and spaced 20 ft. c. to c. On the rear end of these were three heavy timbers on which was carried the two-drum 7x10-in. hoisting engine. This part of the driver did not differ much from the ordinary type of "creeper" driver. The frame supporting the leads differed from the usual construction, however, in that the shear-legs were kept parallel and 20 ft. c. to c., or in the same plane as the gunwales, and did not come together at the top to make an A-frame, as on the usual driver. They were well braced together and at the top there was a 40-ft. timber resting upon them and securely fastened to each leg. This frame was held in place in the usual manner, with cables which ran from the top of the frame on either side of the gunwale on the same side.

On the 40-ft. cap timber was a track for traversing the leads. There was also a heavy timber across the front ends of the gunwales and in the same vertical plane as the 40-ft. timber on top of the shear-legs. The leads were of the usual type and made of wood, with a steel hood securely fastened to them near the top. In this frame or hood there was a heavy sheave or wheel which ran on the track on the top beam. With this arrangement the leads could be traversed about 18 ft. on either side of the center line of the bridge. A 2,500-lb. drop hammer with follower block was used. Arrangements were made on the top and bottom beams to fasten the leads securely at almost any spacing.

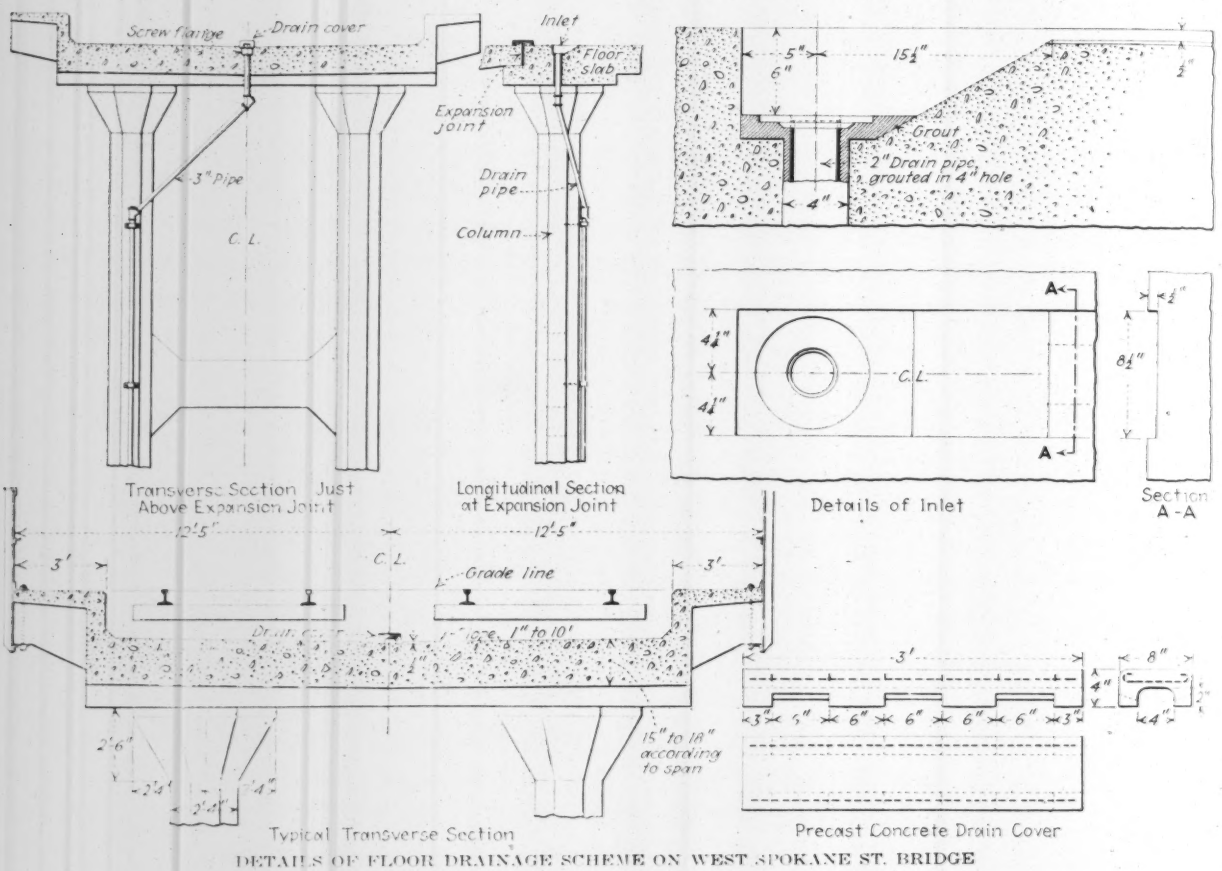
The 53 trestles were built by the Austin Bridge Co., Dallas, Tex., with Joe W. Grace as superintendent. They were designed and constructed under the direction of N. E. Lant, bridge engineer of the Louisiana Highway Commission, with George Robert as resident engineer.

From Job and Office

HINTS THAT CUT COST AND TIME

Floor System Drainage Scheme for Concrete Railway Bridges

A METHOD of draining concrete bridge floors and providing a means of escape for the water so as to avoid unsightly leakage through expansion joints has been worked out by the bridge department of the city of Seattle for the West Spokane St. bridge in that city. The scheme is applicable only to railway bridges because it depends upon using the ballast as a pervious covering for the main drain laid along the center line.



DETAILS OF FLOOR DRAINAGE SCHEME ON WEST SPOKANE ST. BRIDGE

The West Spokane St. bridge is built on a slight grade and the floor slabs, 15 to 18 in. thick, were made to slope from each side toward the center on a grade of about 1 in 10. Thus water drains from either side toward the center line and the grade of the bridge determines the direction of flow along the center line.

In the center of the floor slab a longitudinal depression ½ in. below surface level and 8½ in. wide was formed in the concrete and in this channel are placed precast concrete drain covers. These were cast in 3-ft. sections,

From Job and Office

FOR CONTRACTOR AND ENGINEER

as shown in the drawing, and the design is such that water may enter from either side and pass freely down the center in the arched chamber formed by the shape of the concrete section.

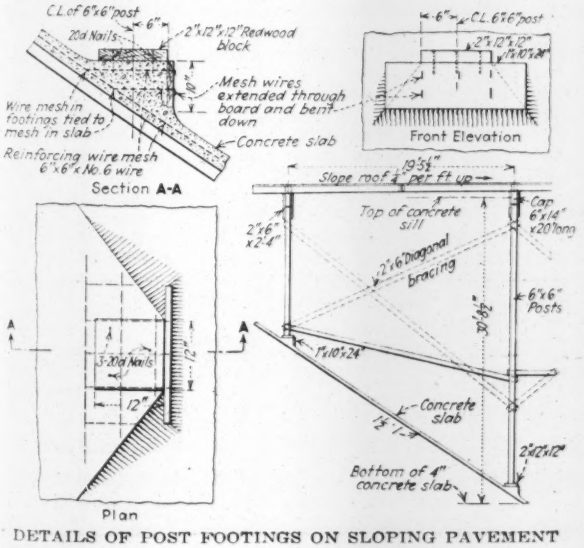
Water collected in this way is conveyed down the center line of the bridge until it reaches an expansion joint. On this bridge with expansion joints in the floor slab placed at every four spans the length of the central drainage channels is about 108 ft. That is, a downspout was provided every 108 ft., thus making the drainage system complete between any two adjacent expansion joints.

The central drainage channel terminates on the upgrade side of each expansion joint in a depression in the concrete whence the water escapes through a 3-in. pipe down one of the supporting columns, as shown in the drawing. As a further protection against the escape of water through expansion joints the edges of both floor slabs at the joint are thickened to raise a barrier to any flow along the floor. These thickened edges are covered by an inverted channel, a single channel spanning the raised edges on both sides of the joint, thus preventing any water that might come in directly above the joints from going through and causing unsightly discolorations.

These details were worked out under the direction of A. Munster, acting bridge engineer, city of Seattle.

Making a Good Column Footing on a Concrete Paved Slope

A MEANS of providing a suitable support for a post or column on sloping pavement has been devised by the Standard Oil Co. and is now extensively used in its storage reservoirs, being considered an improvement over methods previously used. The support consists of a "step-footing" or flat-topped thickening of the pavement built up behind a single form board which is held in place by a tie of reinforcing mesh, as shown in the accompanying illustration.



DETAILS OF POST FOOTINGS ON SLOPING PAVEMENT

The position of the footing is first located at the time the mesh reinforcing for the slab as a whole is placed. At this time two small sections of mesh are fastened one above the other to the reinforcing that is to be embedded in the center of the slab. Later, when the concrete is poured, care is taken to leave these ties projecting above the surface of the slab so they may be readily found; other than this the main concreting crew does no work on the footings.

As soon as the regular crew is out of the way, however, and before the concrete takes its set, a two-man crew, usually selected from the best concrete finishers on the job, makes up the footing as a special hand-troweled job. This crew uses wide boards to get over the newly poured concrete slabs. They first make such adjustments of the projecting mesh as is necessary to line up the footing properly and then place a rich concrete mix and trowel it up as shown in the drawing.

Job and Office Notes

In Moving Traction-Wheeled Power Shovels comparatively short distances about the state, we have had some difficulty during warm weather from the fact that the wheels picked up the surface of bituminous or oil-treated roads. This includes bituminous patches or the treatment of concrete roads. The Connecticut State Highway Department has expected us to pay for whatever damage we do to the pavement and though this has never been very large, some means to cut down this small expense was considered. Therefore we conceived the idea of using old truck tires on the wheels. We found that a 14x40-in. tire would just slip over the wheels of our shovels. So we took four of these tires which were still in fair condition and had them drilled so that when slipped over the shovel wheels, they could be bolted with ¾-in. bolts. The same holes in the wheels that are used for the cleats were used for this tire bolting. We find that we are able to put these tires on in about two hours time and that the danger of picking up the surface of the road is entirely eliminated.—ALRERT B. BLAKESLEE, C. W. Blakeslee & Sons, General Contractors, New Haven, Conn.

Composite Piles, Consisting of a Poured Concrete Section on top of the driven wood pile, were recently used for the foundation of a building at Detroit, Mich., and a feature of this work was the driving of lengths of spiral lockseam pipe by the piledriver to serve as the forms for the concrete. After the wood piles had been driven nearly to the floor of excavation, each pile head was trimmed to form a dowel and to give a seat for the steel pipe, which was set in position. A follower was then placed inside the pipe and the pile was driven to full depth by a steam pile hammer. The follower was then withdrawn, a block placed on top of the pipe, the follower seated on the block, and the pile hammer then drove the pipe down to its seat on the wood pile. Loose caps were placed on the pipes to exclude dirt. The pipes are said to have stood the driving without damage or distortion. At one time a trench filled with water which overflowed into a pipe, but this was pumped out, as the lockseam pipe was watertight. Steel reinforcing bars were placed in the pipes, which were then filled with concrete. These pipes, made of No. 16 and No. 14 steel plate, were 12 in. in diameter and 12 or 14 ft. long.

By Putting a Double-Hose Connection on their mixer, during the past season Foster & Creighton Co., of Nashville, Tenn., added 50 to 75 sq.yd. a day to their concrete pavement yardage according to *Concrete Highway Magazine*. Two 100-ft. lengths of hose were used with double hose connection and one was always attached to both mixer and water line, ready to supply water. The idle hose was carried ahead by two handy men who attached it to the water line. When the mixer had advanced far enough the idle hose was attached to the spare connection and the water turned on. Then the other hose was disconnected and carried forward.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

Direct Oxidation Process of Sewage Treatment at Allentown, Pa.

Sir—We have noted the editorial and article in your issue of Sept. 9, pp. 409 and 422, based upon that part of the report of Metcalf & Eddy to the city of Allentown, Pa., which relates to the direct oxidation of sewage.

We are surprised at the unequivocal acceptance by *Engineering News-Record* of the views of Mr. Eddy which are based on his interpretation of analytical data, much of which is presumptive and ignores physical conditions that spontaneously brought forth the favorable comment of his representatives engaged in the Allentown investigation. We submit that:

(1) In December, 1918, the Pennsylvania State Department of Health investigated this process as operated at a demonstrating plant at Easton, Pa., and obtained the data shown by Table I.

TABLE I—PENNSYLVANIA STATE DEPARTMENT OF HEALTH TEST, EASTON DEMONSTRATION PLANT
Chemical Results in Parts per Million

Sample	Bacteria		Solids		Alkalinity	Nitrogen				Oxygen		Relative Stability
	Total	B. Coli	Total	Suspended	$CaCO_3$	Free Ammonia	Total Organic	Nitrite	Nitrate	Consumed	Dissolved	in per Cent
Screened sewage	582,000	28,400	248	69	94	11.5	34.2	0.05	0.45	52	5.7	30
Cell effluent	55,700	0	608	215	292	9.2	21.5	0.06	0.93	44	6.8	94
Basin effluent	10,300	0	640	26	...	9.3	21.6	0.06	0.90	44	...	95

TABLE II—FULLER & McCLINTOCK TEST, ALLENTOWN PLANT
Chemical Results in Parts per Million

Sample	Bacteria		Solids				Alkalinity		Nitrogen			Oxygen					
			Suspended		Dissolved		Total as	Caustic as	Free Am-	Total Or-		Consumed		Dissolved			
	Total	B. Coli	Total	Volatile	Total	Volatile	$CaCO_3$	CaO	monia	ganic	Nitrite	3 Min. 20 deg.	30 Min 100 deg.	Initial	48 hour	De-mand	Chlor-ide
Screened sewage	540,000	10,000	186	96	314	148	227	0	11.3	25.4	0.67	8	20	4.5	0.14	4.36	41
Cell influent	74,400	10	...	...	...	...	152	59	10.0	...	0.21	6	33	...	...	...	44
Cell effluent	19,900	0	384	113	361	188	150	54	10.0	18.2	0.19	5	42	6.2	4.55	1.65	41
Settled cell effluent	3,600	1	61	...	...	...	128	39	9.1	9.5	....	3	18	...	....	....	44

In view of these results which showed that a high bacterial removal, a substantial reduction in organic nitrogen and an effluent of high stability had been obtained, a permit was given in October, 1919, to the city of Allentown for the construction of sewage-works embodying the direct oxidation process. This plant has been in continuous operation since July, 1921, and during this five-year period the Department of Health has made no further study of this system. The daily records of the city chemist over this period show that the process is efficacious and gives an effluent of low bacterial count and high stability. Physical conditions about the plant are mute testimony that the operation of the process is unattended by nuisance.

(2) Toward the end of November, 1921, the firm of Fuller & McClintock was commissioned by private interests to investigate this process at the Allentown plant, and arrangements to this end were made with the city engineer with the understanding that he was to receive copies of all analytical results. Table II gives the average results of the chemical and bacterial analyses.

In making the dissolved oxygen determinations it was noted that the cell influent consumed permanganate at a distinctly higher rate than the cell effluent. This decrease in the avidity of the sewage for permanganate upon passing through the cell is illustrative of the oxidative effect of electrolysis upon the unstable organic matters.

The average analytical results set forth above are in very close accord in their trend with the findings of the Pennsylvania State Department of Health at the Easton demonstrating plant.

In the course of their investigation Fuller & McClintock carried out several tests in an effort to determine the relative stability of the Allentown effluent, using the prescribed methylene blue method. Samples of the straight effluent, neutralized effluent and neutralized and seeded effluent were treated with methylene blue and incubated at 37 deg. C. with the result that the neutralized and seeded sample was decolorized in 22.5 hours. This would be indicative of a stability of some 37 per cent, a value which is at variance with the analytical and physical results obtained from the operation of this process.

(3) It was contended that the causticity acted as an inhibiting or disinfecting agent which when neutralized or destroyed by dilution would permit the bacteria of the stream to act on the constituents of the effluent with putrefactive results. As a consequence, Fuller & McClintock were commissioned to participate in a series of tests, made in April, 1922, to ascertain whether or not the effluent of the Allentown sewage-works would become nuisance producing after the causticity was removed by dilution with river water. The dilution of the effluent with river water whereby the causticity is destroyed and the bacteria of the stream serve for inoculation is representative of actual stream conditions. To this end samples of the effluent were diluted with river water to such an extent that all the causticity was removed, the dilutions being one part effluent to four parts by volume of river water. Each diluted sample was divided into three parts for the determination of the dissolved or bio-chemical oxygen demand, the relative stability with methylene blue and the effects of standing in open containers at room temperature, with the notation of such physical changes as clarity and odor. By agreement the duration of the tests or incubating period was 60 hours at 20 deg. C. The results are shown in Table III.

At the conclusion of these tests the city chemist replaced the methylene blue samples in the incubator where they remained for 40 days and were discarded while still blue. The results of these tests are indicative of the stability of the effluent when discharged into a stream and prove that the contention, in which it is claimed that the stability is due to the causticity, is fallacious.

(4) Beginning in July, 1922, an investigation, which extended over a period of some five weeks, was made of the Allentown plant by the George A. Johnson Co. During this investigation composite samples, each made up of five indi-

TABLE III—STABILITY OF THE ALLENTOWN EFFLUENT, FULLER & McCLINTOCK TEST
Chemical Results in Parts per Million

Sample	Alkalinity as $CaCO_3$								Dissolved Oxygen			Stability		
	Before Dilution				After Dilution							Meth. Blue		Physical
	Total	Caustic	Normal	Bi-carb.	Total	Caustic	Normal	Bi-carb.	Initial	Final	Demand	Initial	Final	Test
Final Effluent	260	60	200	0	140	0	80	60	9.6	1.6	8.0	Blue	Blue	Clear and odorless
Final Effluent	245	85	160	0	135	0	80	55	9.4	1.7	7.7	Blue	Blue	Clear and odorless
Cell Effluent settled 2-hrs.	260	150	110	0	145	0	120	25	9.3	1.5	7.8	Blue	Blue	Clear and odorless
Cell Effluent, settled 2-hrs.	240	110	140	0	135	0	80	55	9.2	0.05	9.75	Blue	Blue	Clear and odorless
River Water	110	0	0	110	...	...	...	...	10.2	9.4	0.8	Blue	Blue	Clear and odorless

TABLE IV—GEORGE A. JOHNSON CO. TESTS, ALLENTOWN PLANT
OVERALL EFFICIENCY OF PLANT
Chemical Results in Parts per Million

Samples	Bacteria—Total	Bacteria—B. Coli	Suspended Solids—Total	Suspended Solids—Volatile	Alkalinity—Total $CaCO_3$	Alkalinity—Caustic CaO	Nitrogen—Free Ammonia	Nitrogen—Organic—Total	Nitrogen—Organic—Dissolved	Oxygen Consumed 30 M. 20 deg.	Chloride	Stability Methyl Blue per Cent
Screened sewage	1,724,000	88,700	126	100	276	0	22	26.4	10.1	14.8	124	
Cell effluent, settled 1-hr.	12,000	18	69	46	...	53	13	14.6	7.7	8.1	123	80

TABLE V—CHEMICAL EFFECTS OF ELECTROLYSIS, ALLENTOWN PLANT
Chemical Results in Parts per Million

Samples	Alkalinity CaO	Nitrogen—Total Organic	Nitrogen—Nitrite	Nitrogen—Nitrate	Oxygen Consumed 30 Min. 20 deg.
Cell influent	53	26.4	0.41	0.38	15.2
Cell effluent	53	17.3	0.41	0.74	14.3

vidual samples taken at 15-minute intervals, were collected from the several sampling points at three periods during the daily runs. This practice permitted the analyses to be carried out at the city laboratory almost immediately after collection, and dispensed with the use of preservatives. Thus the value of the analytical data was not vitiated by the chemical action of any preservative nor by the effects of a prolonged storage period prior to analysis. The average analytical results obtained from the tests made upon the normal operation of the process are given in Tables IV and V, the first of which shows the overall efficiency of the plant and the second the chemical effects of electrolysis.

In these tests it will be noted that there was a very high removal of bacteria, a substantial reduction in organic nitrogen and oxygen consuming power and that the cell effluent was of relatively high stability. Additional samples of the cell effluent, settled for one hour, were diluted 1:4 with river water and allowed to stand in open narrow-necked containers at 30 deg. C. in an attempt to imitate the condition that would obtain in a stream receiving this effluent. This dilution was sufficient to remove all causticity. It was noted that these samples consumed only 2 p.p.m. of dissolved oxygen in a period of five days.

The results of this investigation indicate in a conclusive manner that the effluent from this process will not create a nuisance when discharged into a stream, even though the dilution afforded be as low as 1:4, and observations and tests show a remarkable freedom from nuisance about the works, including the sludge-drying beds which were in use at the time.

The wet sludge as applied to the drying beds contained 94 per cent moisture and was free from B. Coli and the customary offensive odors of the biologic sludges. In six days the moisture content was reduced to 71 per cent, and the sludge was ready for removal. The wet sludge diluted 1:5 and 1:50 with river water had a relative stability of incubation of 75 and 99+ per cent, respectively.

(5) During the five-year period of operation of the Allentown sewage-works daily analytical records were kept by the city laboratory. From Dec. 9, 1925, to the last tabulated record of July 31, 1926, the analytical determinations were conducted in accordance with the "Standard Methods of Water Aanalysis." These records show the average results produced by the direct oxidation process to be as given in Table VI.

While the routine analyses of the city laboratory do not include the determination of solids and the nitrogen compounds, the work is sufficiently complete to show a high reduction in bacteria and bio-chemical oxygen demand and is indicative of an effluent of high stability.

TABLE VI—ALLENTOWN CITY LABORATORY RESULTS
Chemical Results in Parts per Million

Sample	Bacteria—Total	Bacteria—B. Coli	Caustic Alkalinity CaO	Oxygen Consumed	Biochem. Oxygen Demand	Stability Neutralized and Seeded
Crude sewage	678,623	70,710	—	116	239	11
Cell effluent	91,545	3,923	59	109	214	70
Basin effluent	39,782	1,195	38	53	75	90

(6) The results obtained by Metcalf & Eddy differ markedly with respect to the determination of organic nitrogen, oxygen consumed, bio-chemical oxygen demand and stability from those of Fuller & McClintock, the George A. Johnson Co. and the city laboratory. This is apparent from Table VII in which the results of all tests and investigations of the Allentown plant are set up for comparison in the order of their occurrence.

(7) It is not logical to assume that of four different investigations three are in error and only one is correct. It is far more pertinent to inquire into conditions surrounding an investigation which yields discordant results for the purpose of ascertaining the probable cause of the discrepancies. The abstract of the Metcalf & Eddy report as

TABLE VII—COMPARATIVE ANALYTICAL DATA
DIRECT OXIDATION PROCESS AT THE ALLENTOWN SEWAGE WORKS

Sample	Bacteria—Total	Bacteria—B. Coli	Solids—Total—Total	Solids—Total—Volatile	Solids—Suspended—Total	Solids—Suspended—Volatile	Alkalinity—Total	Alkalinity—Caustic	Alkalinity—Bicarbonate	Alkalinity—Carbonate	Nitrogen—Ammonia	Nitrogen—Nitrite	Nitrogen—Nitrate	Nitrogen—Albuminoid—Total	Nitrogen—Albuminoid—Dissol'd	Nitrogen—Organic—Total	Nitrogen—Organic—Dissol'd	Oxygen Consumed—Total	Oxygen Consumed—Dissol'd	Biochemical Oxygen Demand	Chloride
Investigator																					
Fuller-McClintock																					
Screened sewage	340,000	10,000	500	244	186	96	227	..	...	...	11.3	0.67	....	....	....	25.4	....	20	..	...	41
Cell effluent	12,900	0	745	301	384	113	150	54	...	...	10.0	0.19	....	....	....	18.2	....	42	..	...	41
Final effluent																					
Cell effluent settled	3,600	1	...	...	61	...	128	39	...	...	9.1	....	....	....	....	9.5	....	18	..	...	44
Reduction per cent	99	99	...	...	67	...	44		...	...	19	....	....	....	....	62	....	10	..	...	
Johnson Company																					
Screened sewage	1,724,000	88,700	...	...	126	100	276		...	...	22	0.41	0.38	....	....	26.4	10.1	14.8	..	...	124
Cell effluent	...	...	...	...	...	...	...	53	...	...	...	....	....	....	....	17.3	....	15.2	..	...	...
Final effluent																					
Cell effluent settled 1 hr.	12,000	18	...	...	69	46	...	53	...	...	13	....	....	....	....	14.6	7.7	8.1	..	...	123
Reduction per cent	99	99	...	...	45	54	...	..	...	...	41	....	....	....	....	45	24	45	..	...	
Metcalf-Eddy																					
Crude sewage	768,690	122,500	657	382	139	121	225	0	225	0	15.40	0.29	0.25	3.25	1.15	7.52	2.46	155	82	188	62.
Cell effluent	77,287	8,825	996	306	611	141	106	4	0	102	12.25	0.49	0.93	3.40	2.44	7.52	5.92	168	88	219	62.5
Final effluent	2,330	724	440	191	50	34	101	15	0	86	10.37	0.54	1.12	2.40	2.00	6.08	5.44	94	86	122	62.5
Reduction per cent	99	99	33	50	64	72	55	..	..	...	33	....	....	....	....	19	....	39		35	....
City Laboratory																					
Crude sewage	678,623	70,710	...	...	...	...	...	...	...	...	.....	....	....	....	....	....	....	116	..	239	....
Cell effluent	91,545	3,923	...	...	...	...	...	59	...	...	.....	....	....	....	....	....	....	109	..	214	....
Final effluent	39,782	1,195	...	...	...	...	...	38	...	...	.....	....	....	....	....	....	....	53	..	75	....
Reduction per cent	94	98	...	...	...	...	...	...	...	...	.....	....	....	....	....	....	....	54	..	68	....

All analyses made in accordance with "Standard Methods of Analysis" of the American Public Health Association, except "Oxygen Consumed" by Johnson Co. in which temperature was 25 deg. C. and digestion period 30 minutes.

published in *Engineering News-Record*, Sept. 9, 1926, does not disclose the details of the test procedure as set forth in Appendix C of the full report.

It was noted that electrolyzers 1 and 3 were of a different type than No. 2. The attention of the representatives of Metcalf & Eddy was directed to the fact that the No. 2 unit required much less head at its rated capacity than either of the other two units, the average operating head for a flow of 700 gal. per minute being for Nos. 1 and 3 about 2.5 ft. and for No. 2 somewhat less than 1.25 ft. Thus, with the units connected in a common piping system and under identical conditions of head, the flow through No. 2 would be in excess of the combined flow through the other two units.

Consequently, with recorded average flows of close to, and in some cases in excess of, 1 m.g.d. it is safe to assume that the maximum daily flow was at a rate of from 1.5 to 2 m.g.d. In fact it is recorded that on four of the seven days of the test run it was necessary to use either unit in particular those of the determination of the perishables upon which the greatest interpretative significance is laid, i.e., organic nitrogen, oxygen consumed, bio-chemical oxygen demand and stability. In consequence, the statement that the purification is inadequate is without foundation in fact.

(8) The cost data of any sewage treatment project should be carefully analyzed in order that the total cost of treatment for which the taxpayer must provide is not obscured by the manner in which the operating costs are presented. Taxes must be adequate to provide for both the interest on the bonds covering the construction cost of the project as well as for its operation. So long as the total cost of treatment is the same for several projects the ratio of capital to operating charges is a matter in which the taxpayer is far less concerned than the engineer who advocates one of the several projects. The cost figures as set forth in Appendix C of the Metcalf & Eddy report appear to be substantially correct, but it should not be inferred that the cost of treatment by the direct-oxidation process is $50 as

TABLE VIII.—COMPARATIVE COST ESTIMATES FOR IMHOFF TANK AND DIRECT OXIDATION PROCESS PLANTS FOR ALLENTOWN, PA.
Works Designed for Daily Average Flow of 17.3 M.G.; Maximum Capacity of Works = 26 to 30 M.G.D.

ESTIMATED CONSTRUCTION COSTS

Items	Metcalf & Eddy-Imhoff Filter Plant Excl. Eng. & Cont.	20% Eng. & Con.	Per M.G.	Items	Direct Oxidation Plant Excl. Eng. & Cont.	20% Eng. & Con.	Per M.G.
Racks	$7,000	$8,400	$486	Grit chambers	$15,000	$18,000	$1,040
Pumping station	96,000	115,200	6,660	Building	109,000	130,800	7,560
Detritus plant	93,000	111,600	6,450	Pumping equipment	24,000	28,800	1,634
Venturi meter	7,500	9,000	520	Screen and clarifier mech.	75,000	90,000	5,210
Imhoff tanks	415,000	498,000	28,800	Flow meter	2,500	3,000	174
Effluent screens	8,000	9,600	555	Causticizing tanks	12,000	14,400	834
Filters	665,000	798,000	46,100	Clarifier tanks	63,000	75,600	4,380
Humus tanks	140,000	168,000	9,700	Lime handling equip.	20,800	24,960	1,441
Outfall and outlet	10,000	12,000	694	Electrolytic equip.	500,000	600,000	34,610
Sludge beds	82,000	98,400	5,690	Sludge drying equip.	90,000	108,000	6,250
Incinerator	11,000	13,200	763	Outfall and outlet	7,500	9,000	521
Grounds	15,000	18,000	1,040	Grounds	15,000	18,000	1,040
Dike	26,000	31,200	1,800	Dike	26,000	31,200	1,800
Chlorine plant	10,000	12,000	694				
Totals	$1,585,500	$1,902,600	$109,952	Totals	$959,800	$1,151,760	$66,514

ESTIMATED OPERATING COST

Operating Charges	Metcalf & Eddy-Imhoff Filter Plant Total Per Year	Per Capita	Per M.G.	Operating Charges	Direct Oxidation Plant Total Per Year	Per Capita	Per M.G.
Renewals and repair	$17,400	$0.14	$2.76	Renewals, repairs and supplies	$17,000	$0.13	$2.69
Power	24,000	0.19	3.81	Power	29,275	0.23	4.63
Labor	29,100	0.23	4.62	Labor	18,636	0.14	2.95
Supplies	8,650	0.07	1.37	Lime*	52,038	0.41	8.24
				Fuel oil	25,623	0.20	4.07
Totals	$79,150	$0.63	$12.56	Totals	$142,572	$1.11	$22.58

ESTIMATED TOTAL COST OF TREATMENT

Cost Charges	Metcalf & Eddy-Imhoff Filter Plant Total Per Year	Per Capita	Per M.G.	Cost Charges	Direct Oxidation Plant Total Per Year	Per Capita	Per M.G.
Fixed charges–Interest 5%	$95,130	$0.74	$15.10	Fixed charges–Interest 5%	$57,588	$0.45	$9.14
Depreciation 1.783%	33,923	0.26	5.38	Depreciation 1.783%	20,538	0.17	3.23
Operating charges	79,150	0.63	12.56	Operating charges	142,572	1.11	22.58
Totals	$208,203	$1.63	$33.04	Totals	$220,698	$1.73	$34.95

Capital charges are inclusive of engineering and contingencies.
*The high alkalinity of the sewage is due to the hardness of the water supply, and is responsible for the time costs.

No. 1 or 3, or both, during part of the time in addition to No. 2 which was used continuously. It is, therefore, certain that periodically during at least four days of the test run the No. 2 unit was operated far in excess of its rated treating capacity of 700 gal. per minute.

Had the samples taken at half-hour intervals been composited over a shorter period than 24 hours mentioned, and had a complete analysis been made daily instead of making a single composite for the entire week and completing the analytical work in Boston at some later date, the deleterious effect of operating the electrolyzer at excessive rates with a consequent contamination of the composite samples and the contents of the settling basin would have been apparent at once. Even had the operating procedure been such as to give significance to the data obtained from the analysis of the samples—and it was not—the collection of composite samples over a 24-hr. period and the prolonged contact of the composite for the week with the preservatives was not in accordance with the best practice. The decomposition which sewage undergoes upon standing, the effect of caustic upon prolonged contact with certain organic matters which is not prevented by preservatives per se, and the effect of the preservatives themselves all tend to induce changes in the composition of samples, the magnitude of which depends upon the length of the period between the time the first portion enters a composite and the time of analysis.

These errors of omission and commission in the investigation of Metcalf & Eddy affect all the analytical results and compared with $33 per m.g. for the method recommended by Metcalf & Eddy. In the former case the cost is based upon the treatment of 3 m.g.d. and in the latter upon 17.3 m.g.d. Were the costs of both methods computed upon the same treating capacity and mechanical sludge drying included in the former case the costs would be almost identical, as is shown in Table VIII.

(9) The amount of sludge produced from house sewage by the direct oxidation process is naturally a direct function of the bicarbonate alkalinity of the sewage, which in turn is itself a function of the temporary hardness of the water supply. The lime used to render the sewage slightly but definitely caustic prior to electrolysis reacts with the bicarbonate to form normal carbonate of lime which is precipitated and removed in the settling basin. Consequently, the quantity of sludge will vary in different localities, the magnitude of the variation depending upon the temporary hardness of the water supplies. It has been the experience that when the Allentown plant was operated in accordance with the dictates of the process and within the rated capacity of the several electrolyzer units the resultant sludge had a faint ammoniacal or mortar-like odor, dewatered rapidly and did not give rise to odors of putrefaction nor the formation of gas. On the other hand, with any deviation in the operating conditions it has been noted that the characteristics of the sludge were quite the contrary.

There is a marked distinction between a soil corrective and a fertilizer. A sewage sludge for which a fertilizer

value is claimed necessarily contains nitrogen in organic combination and is, therefore, unstable. Because of its low nitrogen and high lime carbonate content the direct oxidation sludge is admittedly unsuited as a fertilizer but is of considerable value as a soil corrective.

Experiments on a practical scale have shown the feasibility of mechanical dewatering and drying of the sludge, and indicate the cost of the operation to be less than the expense incurred in charging and discharging sludge-drying beds. The analyses of the Allentown sludge show that it contains on the commercially dry basis 67 per cent of calcium carbonate, 2.13 per cent of calcium phosphate and 9.4 per cent of organic matter. The agricultural benefits derived from the use of calcium carbonate in the form of air-slaked lime and pulverized limestone in the correction of soil acidity are well established, and the analyses of the sludge show that it, too, is well suited for this purpose and that it has the additional advantage of increasing the phosphates and soil humus. The existing demand for a product of this character indicates that the sludge when dried will be readily disposed of, and for a sum that will at least defray the expense of drying.

The statement that the "quantity of sludge is excessive" is intended to indicate that in comparison with Imhoff tanks the direct oxidation process produces a greater quantity of sludge. This, of course, is correct, but what of it? In the former case the resultant sludge offends the esthetic senses, is difficult to dewater and has little, if any, commercial value, while in the latter case it is easily dewatered, of a character for which there is already a demand and its handling is unattended by nuisance throughout and with modern equipment presents no problem. Considering its character, it is inconceivable how the quantity of sludge can be construed as being inimical to the treatment of sewage by this process.

(10) If the purpose of the investigation was to determine the adequacy of the treatment afforded by the direct oxidation process then the object was defeated by both the operating procedure and the method of sampling, for the reasons set forth. In view of these considerations the conclusions drawn by Metcalf & Eddy are untenable.

Philadelphia, Pa.
Oct. 15, 1926.

C. P. LANDRETH,
President, Direct Oxidation Process Corporation.

Sir—We have read the letter of C. P. Landreth, president, Direct Oxidation Process Corporation, claiming that the conclusions in our report upon the sewage disposal problem of Allentown, Pa., are untenable. In order that the readers of *Engineering News-Record* may not be misled we make the following statements in refutation of Mr. Landreth's claims.

Mr. Landreth states that the Pennsylvania State Department of Health issued a permit to the city of Allentown in October, 1919, for the construction of sewage-works embodying the direct oxidation process, and has made no further study of this system. It is our understanding that the Pennsylvania State Department of Health after making tests at Easton refused to grant an approval of treatment by the direct oxidation process at Allentown and issued a permit for construction of the direct oxidation plant subject to approval or rejection of the process after making tests of the plant under normal operating conditions. We understand also that the department refused to make the tests until such time as the sewage flow should reach the capacity of at least one of the electrolyzers. This flow was not reached until shortly before our tests were made. We understand that the recommendations in our Allentown report have the unqualified approval of the state authorities.

Mr. Landreth claims that many of the analytical data in our report are merely presumptive. All of our analytical determinations were made in accordance with the American Public Health Association's "Standard Methods for the Examination of Water and Sewage." We know of no better methods. These methods are in use in practically all sewage-works laboratories in this country. We have used them for many years in determining the efficiency of sewage treatment by different processes. Our comparison of the work accomplished by the direct oxidation plant and by other types of sewage treatment plants was based on results obtained by these methods.

Mr. Landreth states that physical conditions at the Allentown plant were ignored. It was necessary for us to base our opinion of the adequacy of the direct oxidation process upon the quality of the effluent produced rather than on physical conditions.

Mr. Landreth calls in question the accuracy of our results of analyses, because they do not agree with those of Fuller & McClintock, the George A. Johnson Co., and the Allentown city laboratory. Considering the variation in conditions under which the samples were collected, it is not to be expected that the results would agree. Our samples were taken every half hour throughout the 24 hours for a complete week under normal operating conditions. When the investigations were made by the George A. Johnson Co. the sewage flow was less than half that at the time of our tests, the sewage being backed up for different periods and the plant operated as a rule in three runs of four or five hours each per day, samples being taken every 15 minutes for one selected hour of each run.

The tests by Fuller & McClintock were apparently made still earlier. We understand that their report to the "private interests" has not been made public. Mr. Landreth states that in making the dissolved oxygen determinations it was noted that the cell effluent consumed permanganate at a distinctly lower rate than did the cell influent. The results for oxygen consumed, by the Standard Method, show a higher figure for the cell effluent than for the cell influent.

The samples collected for the Allentown city laboratory were catch samples taken once a day, ordinarily in the early forenoon when the sewage was relatively strong and the basin effluent relatively weak representing early morning sewage. We have no criticism to make of the analytical work done in the city laboratory.

With all of the selected results presented in Mr. Landreth's letter before us, we can find no reason for modifying the conclusions and recommendations in our Allentown report.

Mr. Landreth contends that the method employed by Fuller & McClintock and by us in determining the relative stability of the final effluent by neutralizing the causticity and seeding with sewage, gave erroneous results. This is the Standard Method. It would be absurd to make this determination without such treatment in samples of sewage effluent practically sterilized with lime. The use of water of the stream in sufficient quantity to properly neutralize and seed the samples would afford sufficient dilution to render the basin effluent stable, even if no lime or electric current had been used.

Mr. Landreth also criticizes the sterilizing of the samples. With respect to the methods of sterilizing used by us, the following statements are made in the American Public Health Association's "Standard Methods for the Examination of Water and Sewage" (6th edition, 1925, p. 70). "Sulphuric acid, when so added as to produce an acidity of 1,000 p.p.m., appears to preserve the original equilibrium between the various forms of nitrogen. Formaldehyde may be added for the preservation of the portion in which are to be determined nitrite nitrogen, total solids, loss on ignition, chloride, and fats. Samples for determination of relative stability, and bio-chemical oxygen demand must be free from preservatives."

Analyses of sterilized samples of sewage and effluents are made at many, if not all, sewage-works laboratories. We have made analyses of such sterilized samples for many years and have used the results of such analyses in comparing the effluent from the direct oxidation process with effluents from other processes. The bio-chemical oxygen demand and relative stability tests were made in daily composite samples without sterilizing. Such changes as might take place during collection of the composite samples would be favorable to the direct oxidation process.

The high bacteria removal referred to in Mr. Landreth's letter was the result of the addition of lime. The results of our tests, given in the tables on p. 423 of *Engineering News-Record* for Sept. 9, 1926, show that no material increase in bacteria removal was accomplished by the electrolytic treatment.

Mr. Landreth criticizes the operating procedure during our tests. A representative of the Direct Oxidation Process Corporation was present on the first day of our test run and we adopted his recommendations for operating the plant. The chief operator, Mr. Heimbach, had been in

charge ever since the plant was put in operation and had been taught how to operate the plant by this representative of the company. During our test run the plant was operated with skill and intelligence. Tests for causticity were made approximately every half hour throughout the test run, and the results used to aid the operator in proportioning the quantity of lime added. This is a refinement not customary in the normal operation of the plant.

Our attention was called to the better operating condition of electrolyzer unit 2, and consequently this unit was used continuously throughout the test run. Mr. Landreth claims that this unit was periodically operated far in excess of its rated capacity of 700 gal. per min., or a rate of a little over 1 m.g.d. As a matter of fact, whenever the rate of flow materially exceeded 1 m.g.d. one or both of the other units were put into service, the valves being controlled by the operator. The flow did reach a rate of approximately 2 m.g.d. for a short period, but all three machines were in use at that time, under which conditions unit No. 2 could not have been overloaded, by Mr. Landreth's own method of computation.

Mr. Landreth suggests that samples should have been taken at short intervals, and analyzed immediately to determine the effect of high rates of flow. As a matter of fact, special tests were made on samples of electrolyzer influent and effluent when the sewage flow was both above and below 1 m.g.d. The values for nitrites and nitrates, which are indicative of the extent of oxidation, are given on p. 423 of *Engineering News-Record* for Sept. 9, 1926. The average rate of flow when these samples were collected was approximately 1.06 m.g.d. Several samples collected at rates of flow below 1 m.g.d., averaging 0.7 m.g.d., showed an average of 0.56 p.p.m. of nitrogen as nitrites and nitrates in the electrolyzer influent and 0.58 p.p.m. in the electrolyzer effluent. Other samples collected when the rates of flow were above 1 m.g.d., averaging 1.3 m.g.d., showed an average of 0.40 p.p.m. of nitrogen as nitrites and nitrates in the electrolyzer influent and 0.46 p.p.m. in the electrolyzer effluent. These results show no disadvantage in the treatment at the higher rates of flow.

In the matter of costs Mr. Landreth grants that the figures set forth in our Allentown report are substantially correct. He overlooks the fact that our estimate of $50 per m.g. of sewage treated at the existing plant was based upon an assumed capacity of 3 m.g.d. average flow as indicated in all published descriptions of the Allentown plant which we have seen. Inasmuch as Mr. Landreth claims that the maximum capacity of each electrolyzer unit is approximately 1 m.g.d. and since maximum rates of flow are double the average, it follows that the existing plant has a capacity of only about 1.5 m.g.d. average flow. Our estimate of fixed charges should accordingly be doubled, bringing the total up to about $67 per million gallons.

This estimate is based on lagooning the sludge. If the sludge were to be dewatered the cost would be materially increased. We agree with Mr. Landreth that the sludge from the direct oxidation process is unsuited for fertilizer. The production of revenue from the sale of dried sludge from this process, as a soil corrective, even though the product be two-thirds slaked lime, is purely hypothetical.

Mr. Landreth defends the excessive production of sludge by the direct oxidation process on the ground of its commercial value and its inoffensive character as compared with Imhoff tank sludge. The sludge produced during our test run had an objectionable odor when pumped to the sludge lagoon and samples standing in the laboratory developed extremely offensive odors of putrefaction. This would not have been true in the case of Imhoff tank sludge from a properly designed and properly operated plant. Such sludge is comparatively small in volume, inoffensive and readily dewatered on drying beds.

We made no estimate of the cost of a direct oxidation plant for treating the entire sewage of Allentown, because our investigations proved conclusively that the effluent would not meet the requirements taking into consideration not only the relation of available oxygen to oxygen demand, but also the fact that the city of Bethlehem takes its water supply from the river a short distance below the point or points where the entire sewage effluent from Allentown will be discharged.

METCALF & EDDY.

Boston, Mass.,
Nov. 24, 1926.

Why a Tunnel at Oakland

Sir—The description in the Oct. 28 issue of *Engineering News-Record* of the traffic tunnel at Oakland is very interesting. The tunnel project is notable and appears to be well designed and carried out. However, I am wondering if you cannot supplement this article by another which will go into the economics of the project. Why a tunnel instead of a bridge? It is presumed the answer would be that the waterway is navigable. If so, might not a bridge with a movable span, frequently opened, have had enough greater capacity and convenience, and been otherwise more desirable to have been justified at even greater cost than the tunnel?

The economic question goes farther back, viz. to the desirability of maintaining the waterway for navigation purposes, at the cost to the public of being obliged to cross through a tunnel, 3,500 ft. of which will be artificially lighted and ventilated, with a roadway but 24 ft. in width and a rise and fall of 80 ft. or more. Were these objections, when taken into consideration for the large volume of traffic which must doubtless exist in order to justify the cost of the tunnel, sufficient to justify the maintenance of the waterway for navigation purposes?

In most cases it is desirable to minimize the barriers between the municipalities or portions of the same city. A tunnel certainly does not do this. Does the retention of the waterway for navigation interfere with the best development of city planning?

These inquiries are partly prompted by your editorial in the same issue on the traffic prospects in the notable Holland tunnel, soon to be opened to use. There are many more or less similar conditions throughout the country where provisions for navigation, visionary in some cases, impose burdensome conditions on all other means of transportation. For many of these cases it would appear that the economics of the situations receives scant study.

This is not intended in any way to criticize the wisdom of the Oakland-Alameda tunnel project, but to draw out, if possible, the facts which made it necessary and advisable to provide a tunnel in preference to a bridge with movable span, or preferably one without provision for navigation.

C. F. LOWETH,
Chief Engineer, Chicago, Milwaukee & St. Paul Ry.

Chicago, Ill.,
Nov. 10, 1926.

[An article in *Engineering News-Record*, Oct. 30, 1924, p. 720, gives some of the reasons why a tunnel was decided on for Oakland instead of a bridge. The conclusions there are not complete answers to Mr. Loweth's query, but they indicate that an investigation was made at the time the tunnel was decided upon. The pertinent text of this earlier article is as follows:

"The crossing of this waterway has been under consideration for a long time. Agitation for the removal of two low-level swing bridges near the crossing now proposed dates back to 1908. One of these structures was a vehicular and street-car bridge and the other was used exclusively by the Southern Pacific R.R. Shipping interests farther up the channel objected to the danger and delay of getting vessels past these bridges and their removal was finally ordered by the War Department in 1916. The objection to these structures cited by the War Department was that they constituted "unreasonable obstruction to the free navigation of the estuary on account of insufficient width of the draw opening, insufficient clearance above water surface under the bridge, and the location of the piers at too close intervals under the approaches to the draw span.

"Plans for a single bascule bridge to take the place of both bridges were then prepared and an apportionment of the cost of $1,800,000 between county and railroad was agreed upon. The removal order, however, was suspended during the War and when it was later renewed the cost of the bridge had increased to $3,000,000. The railroad company then decided to abandon a crossing at this point and dropped out of the negotiations.

"Early in 1923 an investigation was made by George A. Posey, county engineer, to determine the feasibility of building a tunnel instead of a bridge. Traffic counts made at this time and compared with the traffic survey in 1912 showed rapid increases in motors, street cars and ships."
—EDITOR.]

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Tank Sewage Plan Adopted by Detroit City Council

Minority Loses Long Struggle for Fine Screens Instead of Plan of Consulting Engineers

After a year's delay, occasioned chiefly by proponents of fine screens, the city council of Detroit, Mich., adopted the general plan of sewage disposal for the entire city recommended by a special committee on sewage disposal, on the advice of consulting engineers Harrison P. Eddy, Boston, Prof. John H. Gregory, Baltimore, and Clarence W. Hubbell, Detroit (see *Engineering News-Record*, Jan. 21, 1926, p. 112). Besides intercepting sewers, the plan includes an immense pumping station and sewage-works on Rouge River, below Detroit. The sewage-works, to quote from the report of the consulting engineers, will "consist of a skimming-detritus plant and an Imhoff tank sedimentation-sludge digestion plant, suitable equipment for disinfection, conduit to provide proper period of contact for disinfection, and submerged outlet structure, together with the necessary land and structures for dewatering and disposal of sludge." The estimated cost of the project is $39,600,000, of which $15,600,000 is for intercepting sewers for a population of 3,500,000; $2,250,000 for the pumping station, $18,150,000 for sewage-works and $3,600,000 (10 per cent) for contingencies and engineering. The pumping station and sewage-works would provide for a population of 2,400,000, but the sewage-works estimate includes land for treating sewage from 3,500,000 people.

The members of the special commission on sewage disposal, appointed by the mayor and approved by the city council, were: Chairman, A. C. Marshall, vice-president and general manager, Detroit Edison Co.; Perry A. Fellows, city engineer; George R. Cooke, contractor; Francis C. McMath, president and chief engineer, Canadian Bridge Co.; and Lewis C. Rogers, Solvay Process Co. The plan was approved by John A. Reid, commissioner of public works, who is an engineer, when it was submitted in December, 1925.

Action on the plan was delayed from time to time by the city council to give the Sanitation Corporation time to submit and support a substitute plan for a number of fine screen plants in place of the single Imhoff tank installation and accessories advised by the consulting engineers. The corporation claimed that this substitution and accompanying reduction of intercepting sewer construction would save the city millions of dollars.

On Nov. 20, 1926, majority and minority reports were submitted by the city council committee of the whole. Neither report mentioned the long controversy over fine screens. The majority report merely submitted a resolution for the adoption "of the general method and plan of sewage disposal described in the report of the Mayor's Special Committee" (actually described in the report of the consulting engineers). The minority report opposed "the adoption of the report at this time," because of alleged uncertainties as to site; large cost of the project; a claim that the council has already provided for diverting all sewage reaching the river above the water intake; possible coming advances in the art of sewage treatment; length of time required to carry out the official plan, during which pollution would continue and increase; capability of the Detroit River to dilute the sewage if treated at less cost than under the proposed plan; advisability of consulting down-river communities as to the acceptability of the tank plan and agreeing on a joint scheme of disposal; and finally the declaration: "It is our opinion that the plan adopted in the majority report is extravagant, wasteful, and is a plan not required by any existing necessity; and is admitted to involve ultimately a further expenditure of millions of dollars for further purification of [by?] activated sludge or other process."

The vote against the adoption of the minority report was 6 to 3; for the majority report it was 5 to 4, one councilman voting against each report.

John A. Reid, commissioner of public works, informs *Engineering News-Record* that no funds are now available to carry out the official plan, but that money to build that part of the "intercepting sewer from Parkview Ave. to the Belle Isle Bridge was obtained" from bonds.

Engineering Fifty Years Ago

From *Engineering News* of December 9, 1876

ONE of the piers of the railroad bridge at Louisiana, Mo., having been undermined by the current, went down a few days ago with a crash, without warning, taking two long spans of the bridge with it. By good luck there was no one on the falling section at the time, and the only loss sustained by the casualty was that of the property itself, amounting to some $200,000.

To Inspect Mississippi River

The Mississippi River Commission will make a low-water inspection of the Mississippi River on the United States Snagboat Wright commencing Dec. 8. The boat will leave Cairo, Ill., on that date and reach New Orleans, La., several days later. Public hearings will be held at various points along the river on matters connected with river improvement.

St. Lawrence Power License Opposed by Smith

New York State Governor Would Stop Further Action by the Present Power and Water Boards

Issuance of a license to either one of the two companies which have applied to the New York State Water Power Commission by that commission before it goes out of existence on Dec. 31 is being actively opposed by Governor Smith on the grounds that the commission should not take such action after the people of the state have expressed their desire to have the issue of such licenses handled differently through their approval of the plans for reorganizing the state government which go into effect on Jan. 1. The commission, on the other hand, maintains that although the personnel of the commission will be changed after the first of the year and the method of approving its action will be modified, there has been no change in the fundamental law under which it is acting and that it is in duty bound to proceed with the work which it has been carrying on. In order to meet the governor's objections the commission has gone so far as to state that it will write into any license which it issues a provision that the license becomes null and void if the incoming legislature changes the law under which it was issued.

With the reorganization of the state government, the personnel of both the Water Power Commission and of the Water Control Commission is changed somewhat and the governor is given the power of veto over actions of the Water Power Commission in issuing licenses. At present the Water Power Commission is empowered to issue 50-year licenses for power development based upon provisions similar to those of the Federal Power Act.

Governor Smith is opposed to further development of the state's power resources by private capital and has endeavored in the past to set up a "Power Authority" which would undertake the development of power at such sites as those in the international section of the St. Lawrence River which are now being considered by the Water Power Commission. So far he has been unable to get the state legislature to set up such a quasi-municipal corporation.

Governor Smith is also opposing the organization of a river regulating district on the Salmon River Regulating District by the Water Control Commission, a commission which is in a similar state as regards its existence as is the Water Power Commission. Governor Smith opposes action by this commission on the ground that the present law does not provide adequate return to the state for the benefit which the power companies on the Salmon River will obtain from the additional power made available by the construction of storage reservoirs at the headwaters of the Salmon River.

Emergency Supply of Well Water Urged for N. Y.

Water Supply Commissioner Advises Consideration of Offer to Produce 150 M.G.D.

In a modified form, the proposal of the Titus Water Engineering Corporation to install a minimum of a hundred wells on Long Island to yield a minimum of 150 m.g.d. to supplement the water supply of New York City, noted briefly in our issue of Oct. 21, 1926, p. 680, as having been referred by the Board of Estimate and Apportionment to its chief engineer and to the acting chief engineer of the Department of Water Supply, has been reported on by Nicholas J. Hayes, Jr., commissioner of water supply, as worthy of the consideration of the board. The wells would be sunk on land owned by the city in Queens, Kings and Nassau Counties. After tests of individual wells for capacity the city would pay for each well completely equipped at the rate of $75 per gallon per minute of test yield. The contractor would operate each well for a year or less, as determined by the city, and the city would pay the contractor $40 p.m.g. for water delivered, plus the cost of power for pumping up to $20 p.m.g.

Cost of Wells

On the basis of a test yield totaling 150 m.g.d., the wells would cost the city $7,812,500. In addition, the city would have to spend about "$6,500,000 for transmission lines, trunk mains, engineering and inspection, and about $100,000 for power furnished to the contractor during the test period," says Mr. Hayes.

Embodied in the report under consideration are extracts from a report made to Mr. Hayes by W. W. Brush, deputy and present acting chief engineer of the Department of Water Supply. After stating that the Long Island underground reservoir might well be utilized more fully than it yet is, either "to meet a large temporary demand, or a smaller continuous demand," Mr. Brush says: "It is believed that 150 m.g.d. as set forth in the proposal of the Titus Water Engineering Corporation may be secured as an emergency supply in addition to the existing Long Island supply of 112 m.g.d. as developed by the city, though less than half of the 150 m.g.d. should be considered as a dependable supply for continuous draft over a period of years. Approximately 150 m.g.d. should be made available as quickly as possible from the underground water supplies of Long Island in Kings, Queens and Nassau. The necessary wells, equipment, pipe lines and other appurtenances required to make available the proposed 150 m.g.d. to be drawn from the underground water supplies of Long Island should be installed under the direction of the Department of Water Supply, Gas and Electricity at as early a date as possible, in order to reduce the menace to the continuity of water supply in Brooklyn, Queens and Richmond, to provide a supply to supplement the present sources of supply during the periods of low stream flow in the Croton and Catskill watersheds, and to meet the future demands of the city prior to the introduction of a new large source of water supply."

Further on Mr. Hayes quotes Mr. Brush on the reasonableness of the price named in the Titus proposal as follows:

"The proposal fixes a charge of $75 per g.p.m. of yield secured, and it is almost impossible to determine whether the proposed rate is reasonable. The number of reliable concerns driving and equipping large diameter wells, especially to depths over 200 ft., which would be required in part of the development under the Titus proposal, is very limited.

"There are attached hereto three estimates made by the Titus Water Engineering Corporation in support of this charge; one based upon the contract price paid for a similar well recently sunk for the Flatbush Water Works Co. in Brooklyn; a second upon average results secured on Long Island in driving and equipping similar wells; and a third as compared with a similar well and equipment to be installed in Garden City.

"As a further justification of the rate proposed, the contractor cites its success in securing contracts from municipalities and private water companies on competitive bids; its knowledge of underground sources of water on Long Island; the extra risk which must be assumed due to the large volume of water to be guaranteed; the less favorable material that will be encountered; the loss of some of the wells and the large engineering cost to the company.

"As to what the city should pay to the contractor for the special items enumerated as additional justification for its proposed rate is debatable, and any value placed thereon is necessarily a matter of judgment. Based upon the contract prices at which this company has sunk wells, the figures cited in the three estimates referred to appear to be on the whole reasonable; but the overhead charged, the assumed average depth of wells and the average yield of 700 g.p.m. (upon which the unit price of $75 per g.p.m. is based) are also points open to question.

"This average yield of 700 g.p.m. is based upon the number of similar wells driven on Long Island, so that the 10 per cent charged for guarantee or loss of wells appears high.

"Two other proposals have been submitted to drive wells on Long Island to deliver 150 m.g.d., the price quoted in each case being less than half the price quoted in the Titus proposal. In neither case was the proposal in sufficient detail to make a direct comparison with the Titus proposal. One of the companies is a well company that has only recently been organized and therefore has no past record of accomplishment as proof of its ability to undertake the work of the magnitude which the Titus proposal covers. The second proposal was from a consulting engineer who has a patent on a large well, but his well is not adapted for deep wells, being generally designed for wells of considerably less than 200 ft. in depth. With this type of well the deep strata that are to be developed under the Titus proposal could not be secured."

On the unit price for wells Mr. Hays finally suggests that "the Board of Estimate should determine what this rate should be."

The tabulations submitted by the Titus Water Engineering Corporation in support of its proposed unit price per gallon of water per minute per well are based on (1) a single well "recently sunk by the Layne Bowler Company for the Flatbush water-works; (2) on other "Layne wells"; (3) on the figures for a "well and equipment to be installed for Garden City," similar to those proposed for New York City. In each case various adjustments on account of varying conditions were made. In its final figures the Titus Corporation figured overhead at 25 per cent; guarantee to offset unsuccessful wells, 10 per cent; profit, 15 per cent.

Course in Building Construction Established at M. I. T.

A course in building construction to develop professional builders with a broad training in building operations, including business and engineering administration, has been established at Massachusetts Institute of Technology, and will begin in the second term in February. The course was founded by Louis J. Horowitz, president of the Thompson-Starrett Co. of New York, through a grant from the Louis J. and Mary E. Horowitz Foundation.

Professor Ross F. Tucker, a graduate of Technology in the class of 1892, and until recently a member of the construction staff of the Thompson-Starrett Co. has been appointed to take charge of the course.

Training in the new course will include the study of applied mechanics, strength of materials, the chemistry of explosives, cements and protective coatings, rock formations and soil mechanics, surveying, the design of structural steel, reinforced concrete and masonry.

Special attention will be given to training in banking and investment problems to enable the constructor to meet the broader problems of his work in which he will study engineering administration, business, corporate and real estate law, contracts, insurance, estimating, cost analysis and accounting.

The course is designed to give a thorough knowledge of the methods, machinery and appliances that enter into assembling and erection of materials of building, and particularly in the co-ordination of the various crafts and the formulation of time schedules.

The new course, which is designed to qualify men for the building profession in all its aspects, will cover four years and leads to the degree of bachelor of science.

Bureau of Standards Celebrates Its Quarter Centennial

On Dec. 4 the Bureau of Standards at Washington celebrated the quarter-centenary anniversary of its foundation by entertaining a large number of invited guests at a special showing of the various departments of the Bureau and their work. This was followed by a subscription dinner at the Willard Hotel, attended by some 400 of the country's most noted scientists, educators, industrialists, and publicists. Director George K. Burgess presided, and the honor guests at the dinner included George B. Cortelyou, who was the first Secretary of Commerce and Labor upon the establishment of that new department in 1903 and was intimately concerned in the early growth of the Bureau; Dr. S. W. Stratton, director of the Bureau from its foundation for more than 20 years and now president of Massachusetts Institute of Technology; Herbert Hoover, Secretary of Commerce; and Dr. Frank A. Wolff, who was in the office of Weights and Measures of the Coast and Geodetic Survey before the Bureau of Standards was founded, was active in promoting the establishment of the Bureau and has continued his connection with it to the present day. Their addresses, as well as those of David Lawrence, editor of the *U. S. Daily*, described as knowing more about the government of the United States than any one except Hoover; Senator R. B. Howell and William B. Oliver, paid tribute to the high position won by the Bureau in both science and industrial research, and to the spirit and ideals which animate its leaders and personnel.

Senator Howell, one of the few engineers in the membership of Congress, added to his appreciative remarks the suggestion that industry and manufacture may have been favored unduly by the Bureau's investigative work, and that it may now be proper to extend the activities of the Bureau in such a way as to aid agriculture.

Local Agent Demands Income Tax from Detroit Water Board

As his own deduction from a ruling by C. R. Nash, assistant to the commissioner of internal revenue, Washington, D. C., that employees of municipally-owned waterworks must pay an income tax on salaries earned since Jan. 1, 1926, the local collector of internal revenue at Detroit, Mich., on Nov. 29, demanded a return from the Detroit Water Board on the earnings of the water-works of that city, as well as returns by the board of all amounts above $1,500 a year paid by the board to its unmarried employees and $3,500 a year to married employees.

On inquiry made by *Engineering News-Record*, Assistant Commissioner Nash states that the Bureau of Internal Revenue "has never held that the income accruing to a municipally-owned and operated water-works is subject to income tax, and has never instructed collectors and other officers of the Bureau to obtain income tax returns in respect of such income." Mr. Nash adds the following:

"Income derived from a public utility and accruing to a state or a political subdivision thereof is exempt from income tax under Section 213(b)(7) of the Revenue Act of 1926, which reads as follows:

(b) The term 'gross income' does not include the following items, which shall be exempt from taxation under this title:

(7) Income derived from any public utility or the exercise of any essential governmental function and accruing to any State, Territory, or the District of Columbia, or any political subdivision of a State or Territory, or income accruing to the Government of any possession of the United States, or any political subdivision thereof.

"The matter has been taken up with the Collector of Internal Revenue at Detroit. Upon receipt of his report, you will be advised further."

The ruling by Mr. Nash cited at the beginning of this note applied to officers and employees of not only the Detroit and other municipally-owned water-works but also of the Detroit municipal railway, so far as income taxes under the Revenue Act of 1926 are concerned, this despite the decision of the Federal District Court of Michigan that the operation of a street railway by a municipality is the exercise of a strictly governmental function and that therefore the Detroit municipal railway employees were exempt from income taxes. This suit, however, was concerned with the income taxes claimed under the Revenue Act of 1924. The government appealed from the opinion of the Federal District Court but withdrew the appeal on passage of the Revenue Act of 1926, which specifically released municipal and other government employees of taxes claimed on incomes earned prior to 1925. In other words, the Bureau of Internal Revenue appears to give no weight to the Detroit municipal railway decision because it was rendered by a district court and has not yet been upheld on appeal.

Budget Request for Reclamation Totals $12,183,000

Appropriation of $12,183,000 is requested of Congress in the budget submitted Dec. 6 by the Bureau of Reclamation. This is $4,627,000 more than was appropriated for the current fiscal year. The new Owyhee and Vale projects are the list for $2,000,000 and $750,000 respectively, Kittitas for $2,000,000, Sun River for $1,084,000, and Minidoka for $1,742,000.

Atkinson-Spicer Awarded Coolidge Dam Contract

Contract for the construction of the Coolidge Dam on the San Carlos Indian reclamation project in Arizona was awarded Dec. 2 by the Interior Department to the Atkinson-Spicer Co., Los Angeles, Calif. This company's bid was $2,268,525, the lowest one received from nine contractors, who bid for the contract to build the dam. (See *Engineering News-Record*, Nov. 25, p. 886.)

Professor Swain to Address Boston Engineers on Concrete

Prof. George F. Swain of the Harvard Engineering School will give an address on "Why I Prefer Steel to Reinforced Concrete," at the Dec. 15 meeting of the Boston Society of Civil Engineers.

According to a tentative outline furnished the society Professor Swain will give a logical statement of the reasons which have led him to conclude that reinforced concrete has been much overpraised and over-advertised, and that it is being used for a great many structures for which steel would be better suited. He expects to call attention to some inherent qualities of concrete and reinforced concrete which seem to have been largely lost sight of, and to certain possibilities of harm which seem to have been largely forgotten. Professor Swain as a member and chairman of the Boston Transit Commission, has used large quantities of concrete and has advocated its use in many other cases. It is his intention to sound a note of warning against the indiscriminate use of reinforced concrete for any and all purposes.

Army Engineers' Report Opposed to All-American Canal

An adverse report by the Board of Engineers for Rivers and Harbors on the "All-American Canal" has been submitted to Congress by Major General Jadwin, Chief of Engineers, U. S. A. The board is opposed to the proposed canal between the Great Lakes and the Hudson River as an alternative to the proposed improvement of the St. Lawrence River for deep-draft vessels as being much more expensive to build, more difficult to operate and as providing a longer route to European ports. On the other hand General Jadwin states that "the routes from the Great Lakes to the Hudson River is feasible from an engineering point of view, and its construction by the United States Government would probably be justified in the near future, if the plans for the improvement of the St. Lawrence do not meet approval of the legislative branches and executive heads of the two governments."

The estimated cost of improving the St. Lawrence for navigation alone is $173,520,000 for a 25-ft. waterway, which cost will be borne jointly by the two countries while the cost of a 25-channel in the All-American canal is $506,000,000. With 1,365,000 hp. installed in the international section of the St. Lawrence the cost will be from $350,100,000 to $385,500,000 (half of which power belongs to the United States) and when the total of 5,000,000 hp. has been installed the cost will be from $620,000,000 to $650,000,000, or little in excess of the Great Lakes to Hudson Canal with no power. The Chief of Engineers estimates that the value of the power alone would justify the entire St. Lawrence project were it feasible to develop and market so much power within a reasonable time.

A more complete abstract of the report will be given next week.

Ten-Year Reclamation Building Program Proposed

A tentative 10-year construction program for federal reclamation, with a total estimated expenditure of $97,514,000, has been proposed by the Interior Department. This sum will, it is expected, result in the completion of all existing government projects. The program contemplates work on 22 unfinished projects in 17 Western states with annual expenditures averaging between $8,446,000 and $10,826,000. This sum exceeds the probable average annual income of the reclamation fund by about $1,000,000. If adopted, the program will preclude the undertaking of any new projects by the government during this 10-year period.

Expenditures which are to be made on the various projects follow:

A total of $1,291,000 would be spent on the Yuma project to complete the distribution, drainage and power systems. A total of $727,000 would be used on the Orland project in California to construct the Stony Gorge reservoir and complete lateral canal extension and linings.

On the Grand Valley project in Colorado $136,000 would be spent to complete the distribution and drainage systems.

On the Uncompahgre project in Colorado, $500,000 would be spent for the drainage system. On the Boise project in Idaho a total of $6,334,000 is proposed to be used for main canal betterments and drainage on the Arrowrock and Payette divisions.

A total of $8,423,000 would be expended on the Minidoka project in Idaho to complete the American Falls reservoir, the American Falls power development, the Minidoka power development, the South side pumping division drainage and the North side pumping unit. On the Milk River and Sun River projects, both in Montana, $181,000 would be expended on the former and $3,653,000 on the latter for the Gibson reservoir, Fort Shaw distribution system, North side distribution system and North side drainage. On the Lower Yellowstone, $460,000 would be spent; on the North Platte, $707,000 and on the Newlands, Nev., $1,164,000.

It is estimated that it would require $1,001,000 to complete the Carlsbad project, $590,000 to complete the Rio Grande project, $1,831,000 for the Klamath project, $1,000,000 for the Belle Fourche project in South Dakota; $320,000 for the Okanogan and approximately $5,195,000 each for the Riverton and Shoshone projects, both in Wyoming.

It is estimated that more than $20,000,000 would be expended on the Owyhee and Vale projects in Oregon, $17,714,000 on the former and $3,115,000 on the latter. The Salt Lake Basin, Utah, would take $12,400,000 to complete the Echo reservoir and Weber-Provo canal and other divisions, and the Yakima project in Washington would consume $25,579,000 for the storage at Cle Elum reservoir and complete construction of the Roza, Kennewick, and Kittitas divisions.

WASHINGTON NOTES

THE Joint Congressional Committee on Muscle Shoals expects to meet during the first week of Congress to formulate plans for the handling of its bill. The committee also will consider the adoption of a resolution assuring the Secretary of War that it has no objection to the consideration by the Federal Power Commission of applications for preliminary permits on the upper Tennessee.

Senator Deneen, of Illinois, the chairman of the Joint Committee, has stated his intention to press for early passage the bill recommended by the committee. This measure provides for the acceptance of the bid of the thirteen southern power companies.

The proposed resolution dealing with the upper Tennessee, was requested by a delegation of Tennessee business men who came to Washington to urge the Federal Power Commission to act on the applications before it for preliminary permits on the upper river. It was developed that the Secretary of the Interior and the Secretary of Agriculture are ready to act, but as Muscle Shoals comes under the War Department they are disposed to await the pleasure of Secretary Davis.

THE application for license recently filed with the Federal Power Commission by the Savannah River Electric Co. of Greenwood, S. C., covering a 34,560 hp. project on the Savannah River near Clarks Hill, S. C., conflicts with that covered by the preliminary permit already granted to the Twin Cities Power Co. This permit, however, has not been accepted by the Twin Cities Co. The permit was authorized Aug. 19. The delay in acceptance is thought to be due to certain technicalities which the company has to overcome. It is expected that it will be accepted. This will mean that action on the new application would not be considered until the outstanding permit has been disposed of.

NAVIGATION interests are insisting that when the Chesapeake and Ohio bridge at Cincinnati is reconstructed that the clearance between spans be at least 700 ft. Some are asking for 900 ft. of clearance. The railroad company wants to retain its existing piers which are 521 ft. apart. The plan is to extend these piers downstream so as to widen the structure. The contention of those concerned with navigation is that the bridge, which was erected in 1887, practically has to be rebuilt, and that a condition of the new permit should require provision for the increased traffic which soon will be moving on the Ohio.

THE proposed bridge over Chesapeake Bay above Baltimore will require action by Congress. The principal objection comes from the Ordnance Department. The bridge would occupy waters now used in testing of guns and projectiles. The bridge in the proposed location, it is contended, would make necessary the abandonment of the proving grounds at Aberdeen and at Edgewood Arsenal.

Contract Let for High Arch Dam Near Rochester, N. Y.

Contract for the highest concrete arch dam in the East has been let by the Caneadea Power Corp., a subsidiary of the Rochester Gas & Electric Corp. of Rochester, N. Y. The dam is to be built on Caneadea Creek, a tributary of the Genesee River, above Mt. Morris in western New York State. It will be approximately 143 ft. high and of the constant-angle arch type. The dam will be chiefly for storage purposes, the reservoir formed having a capacity of 1,600,000,000 cu.ft., but a power plant will be built at the dam to develop power as the water is released from the storage reservoir. The total cost of the work, including the relocation of several miles of highway, will be about $1,500,000.

Contract for the work has been awarded to Gannett, Seelye & Fleming Engineers, Inc., Harrisburg, Pa., and work on the 50,000 cu.yd. excavation for the spillway will be undertaken this winter. It is expected that the whole work will be completed by the end of 1927.

Flood Overtops Stevenson Creek Test Dam

On Nov. 28 an unexpected test of the experimental arch dam on Stevenson Creek, in California, occurred when a flood caused by heavy rains was held back by debris blocking the sluice through the dam and overtopped the 60-ft. dam. An overflow of 3-ft. depth (estimated) followed, tearing away the observation scaffold on the downstream face. The dam itself apparently was not injured, though at the time of this report water was still flowing over the crest in a thin sheet. Further tests on the structure, planned for January, will probably be deferred because of this occurrence.

Florida Section, A.W.W.A., Is Formed

Sixty water-works engineers, superintendents and operators in Florida met at Tampa on Nov. 18 and organized the Florida Section of the American Water Works Association. The officers elected were: Chairman, Anson Squires, Tampa; vice-chairman, Eugene Masters, St. Augustine; secretary-treasurer, E. L. Filby, Jacksonville. It was decided to hold a spring and fall meeting yearly, the next meeting to be in Hollywood, Fla., in April.

Several papers were presented at the Tampa meeting. Among these, one by Fred J. Stewart, city engineer of Hollywood, dealing with the effect of the recent Florida hurricane on water-works, brought out much discussion as to the lack of knowledge of valve locations and other features of the distribution system and also as to the need for better housing of water-works records.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention and Road Show, Chicago, Ill., Jan. 10-14, 1927.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 12-15, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 19-21, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, Asheville, N. C., Jan. 24-28, 1927.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Quebec, Feb. 15-17, 1927.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 22-24, 1927.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, Ill., March 8-10, 1927.

The Detroit Engineering Society at its Dec. 10 meeting will have a lecture on "Simplified Practice," illustrated by lantern slides, by R. M. Hudson, chief of the Division of Simplified Practice of the U. S. Department of Commerce.

The Society of Terminal Engineers, New York City, will have at its Dec. 14 meeting an illustrated address by Col. William G. Atwood, consulting engineer, New York City, on "Preservation of Marine Structures." Colonel Atwood was formerly director of marine piling investigations for the National Research Council.

Personal Notes

IRVING E. MATTHEWS, since 1916 engineer of water distribution at Rochester, N. Y., has been appointed superintendent of the water department at Rochester, succeeding BEEKMAN C. LITTLE, who held that position for many years and resigned some months ago to devote his entire time to his work of secretary of the American Water Works Association. Mr. Matthews before his connection with the Rochester water department had done railway engineering work and worked on the New York Barge Canal and on sewer construction in Rochester.

MAJ. LEWIS M. ADAMS, Corps of Engineers, recently on duty at the California Institute of Technology, Pasadena, has been placed on the retired list of the Army with the grade of lieutenant colonel. Major Adams has had many important assignments since his graduation from West Point in 1903. He directed road and bridge work in the Philippines, and surveying and highway work with the army of Cuban pacification. From 1907 to 1912 he was in engineering work on construction and completion of Ohio River dams, the last two years as executive officer of the Ohio River Board, at Wheeling, and made special reports on this work. In 1917 he was senior engineer in the first training camp at Fort Sheridan and when he served in France was in charge of construction of the 10,000-bed Advance Section hospital at Remaucourt, with 400 buildings and water, light, sewer and other facilities, and also served at the front later in decisive actions and was cited for distinguished conduct. Since the World War, among other services he was district engineer at Galveston and completed the Galveston sea-wall.

HARRY WARDMAN, president of the Wardman Construction Co. of Washington, D. C., has accepted an invitation from Secretary of Commerce Herbert Hoover to serve on the National Committee on Wood Utilization and has been detailed to the sub-committee on construction. For many years Mr. Wardman has been identified with large building operations in the District of Columbia.

SIDNEY S. ANTHONY, Manchester, N. H., has been appointed superintendent of the Augusta, Me., Water District. Mr. Anthony is a graduate of Northeastern University, and has recently been employed on the construction of the Scituate tunnel at Providence, R. I. He was also resident engineer at Ausable Forks, N. Y., on the construction of an earth dam. Later he was with the New Hampshire Power Co. in the construction of high power transmission lines.

E. J. MCGREW, until now secretary of the Missouri State Highway Commission, has been made a member of the commission, taking the place, on the commission, of THEODORE GARY of Kansas City who resigned.

G. G. EDWARDS and H. P. STOCKTON, of San Antonio, Texas, announce the formation of EDWARDS & STOCKTON, civil engineers, and the opening of offices in the Moore Building, San Antonio, for practice in highway, sewerage, water supply, irrigation and drainage engineering.

JAMES N. KEENAN has been made a field engineer on the staff of the American Institute of Steel Construction; formerly Mr. Keenan was chief engineer of the H. H. Robertson Co., of Pittsburgh. C. ALEXANDER MILLER, formerly of the faculty of the Case School of Applied Science, Cleveland, became field engineer for the Institute some time ago. Both will maintain the contacts of the Institute with engineers, architects, contractors, bankers, municipal authorities, and with the faculties of technical schools.

LIEUT. COMMANDER EDWARD ELLSBERG, who directed the work of raising the submarine S-51 in the summer of 1926, has resigned his commission in the navy.

Obituary

ALBERT H. EMERY, inventor of the Emery testing machinery, died Dec. 2 at his home in Glenbrook, Conn., aged 92 years. His first invention was the well-known testing machine which has been in use for many years at the Watertown Arsenal; it opened a field for experimental work which has since led to important developments in the realm of mechanics. Of his invention and designing also are the two testing machines in the U. S. Bureau of Standards in Washington, D. C., one of 230,000-lb. capacity for tension and compression, and one of 1,150,000-lb capacity for tension and 2,300,000 lb for compression on specimens of all lengths up to 33 ft. One of his latest inventions was a railway track scale which has been used on the Pennsylvania, Illinois Central, and other systems.

ARTHUR F. MACARTHUR, noted railroad construction engineer and member of MacArthur Brothers Co. of New York, died Nov. 30 in Salt Lake City, Utah, where he had gone a month previously for a visit; he was in his 66th year. During his connection with the MacArthur Brothers Co., Mr. MacArthur had supervision of construction of over 8,000 miles of railroad in the United States and of similar work in other countries. He was also connected with the construction of many important reservoirs, dams and aqueducts, including the Boston water supply and the New York water supply, and of several sections of the Chicago Drainage Canal and the Sault Ste. Marie Canal. He had entire charge of the preparation of the grounds for the Chicago Exposition. During the World War period, he had charge, for his firm, of the construction of Camp Merritt the port of Newark terminal, and building construction for the U. S. Shipping Board. Mr. MacArthur was born in New York State in 1860 and educated at Harvard.

T. W. MCARTNEY, county drainage engineer at Yakima, Wash., for eight years but recently employed by an aviation concern of Seattle, died suddenly Nov. 23 in a hotel in Sunnyside, Wash.

JOHN B. HUNTER, former city engineer of Denver, connected with the engineer's office for almost forty years, died Nov. 29, aged 70 years. He arrived in Colorado in 1877 and in 1878 was a member of a United States land survey on the Colorado-New Mexico line. In 1880 he became city engineer and it was under his plans the civic center, the Cherry Creek improvements and many viaducts were constructed.

PHILIP W. CHAMBERLAIN, long an engineer in the Bureau of Sewers, Baltimore, Md., died Dec. 3 aged 73 years. Born in New Hampshire, Mr. Chamberlain went to Cuba in childhood. At the University of Havana he graduated in civil engineering. Later, in Central America he surveyed and constructed the Iztapa R.R. in Guatemala and the Nicaragua Central R.R. in Nicaragua. He was general manager of the Nicaragua National Rys. for several years. In Baltimore he was first surveyor and associate engineer in the Baltimore Bureau of Highways and later was connected with the Bureau of Sewers. He retired about two years ago because of ill health.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Contractors Discuss Used Equipment Practices

Little Trouble in Selling or Trading-In Used Equipment But Price Often Low—Many Sales Made Between Contractors

FOLLOWING previous articles in these pages on the subject of trade-ins and merchandising practices for used construction equipment there is given here a symposium of the views of a number of progressive contractors. The manufacturers' viewpoints and to a slightly less extent those of the distributers were considered in the previous articles.

Contractors are experiencing little trouble in disposing of used construction equipment although a number of them have found that better prices are received when dealing direct with contractors than when selling to dealers or when making trade-ins. They have found that manufacturers and distributers do not wish to deal in used equipment but that many of them buy and sell it nevertheless. They believe there is a place for used equipment on many kinds of jobs, in particular when it is not a rush job and when the used equipment has just enough life left to complete the work in hand. One of the contractors has set up an equipment department which operates as a separate business buying and selling new and used construction machines. By and large the contractor realizes that there is a problem involved in connection with used equipment. And each one is meeting it in his own way as told here.

By Leonard C. Wason
President, Aberthaw Co., Boston

WE HAVE always found the selling of secondhand construction equipment to be a somewhat difficult process. There are not many buyers of secondhand equipment and consequently the price is lower than the intrinsic value of the equipment would indicate. Conversely we have had little difficulty in buying secondhand equipment because there is always apparently more available than is necessary to supply the needs of contractors. Also it has been kept on hand by dealers until disposed of, thus reducing the sales of new equipment.

In each of the larger cities with which we have acquaintance there are one or more dealers in secondhand equipment of various kinds. There are several such in Boston. The type of equipment which we regularly use is operated until it is worn out. When we need something other than this standard we hire whenever possible and only buy when necessary. Buying usually creates the difficulty of disposing of these special pieces of equipment.

During the last few years we ourselves have set up an Equipment Department which operates now as a regular business, renting, buying and selling, new and secondhand equipment.

Manufacturers of equipment should probably keep out of the secondhand business—it is unprofitable for them and often hurts the sale of their new equipment.

By Arthur H. Diamant
Vice-President, Rosoff Subway Construction Co., Inc., New York

THE MATTER of the purchase of equipment of all kinds, as well as its sale for this contractor is entirely in the hands of the writer. We have made it a practice to purchase only new equipment as regards cranes, derricks, hoists, compressors, electrical equipment, pumps, drills, etc. An efficient corps of mechanics, under the supervision of a master mechanic, keeps our plant at all times in very good condition. As a result, we have been enabled to dispose of such equipment as we cannot use, for not less than 60 per cent of its cost price, and oftener, at a higher percentage. We have found that manufacturers do not care to trade in secondhand machinery, and after one or two attempts, we have done a great deal better by selling the used equipment which we do not need, to contractors.

By A. W. Chapman
Secretary, Turner Construction Co., New York

CONDITIONS as regards the merchandising of used construction equipment vary greatly in different sections of the country and must necessarily vary also at different periods.

The question of trading in used equipment in purchasing new is a matter which the manufacturers must settle for themselves. The practice is largely the fault of their own salesmen who offer many inducements to effect sales. They may sell equipment not suited to conditions or guarantee a performance which cannot be obtained. Then they are forced to take back their goods and resell them. This creates a resale department and their competitors follow. Naturally the contractor is going to take advantage of these conditions in purchasing equipment.

As for disposing of used equipment the obvious plan would be to have a central exchange where all such equipment could be listed. But such a plan would be very difficult to carry out. Many contractors cannot hold their equipment but must dispose of it at once, often at a ridiculous price. Much equipment is sold on account of insolvency. A mere listing of equipment gives little idea of its condition. Many listings would be honestly made and many others would prove worthless. For the exchange to inspect and certify the equipment it handles would be an expensive and unsatisfactory operation.

In certain districts there are reliable concerns leasing equipment (some specializing in boilers, others in compressors or hoists) and they often buy and sell secondhand machinery also. They furnish a good medium of exchange as they know their merchandise and can assure satisfaction to the buyer. In other localities junk dealers will buy and sell equipment. They are sometimes unscrupulous, but more often quite ignorant of the machinery they are trying to sell, its use and its condition, and the result is disastrous for the purchaser.

If there were some way in which the number of reliable firms could be increased and their territory of operation widened, it might help the present situation markedly.

By E. W. Watson
Black Hawk Construction Co., Waterloo, Iowa

WE HAVE had little or no trouble in turning in used equipment to manufacturers' agents in trade for new equipment of like make or character.

We realize that these agents are making an attempt to get out of the secondhand equipment business and it seems to us that their problem is very similar to that of the automobile dealer. If they make proper allowance for used equipment most of them can dispose of it without loss, either to contractors desiring secondhand equipment or to some secondhand equipment dealers who make a specialty of rebuilding and reselling construction machinery.

Although we have had very little experience in buying used equipment we believe that in the near future something will have to be worked out in the way of handling used machinery.

By H. Stanley Bent
Vice-President and General Manager, Bent Brothers, Inc., Los Angeles

IN OUR experience we have until very recently kept practically all of our used equipment and made no effort to sell it on the theory that it would be worth more to us on a new job than we would be able to get for it if we sold it. We are just now departing from that practice because we have accumulated such a tremendous amount of equipment that we feel it unwise to carry all of it.

We have never attempted to trade in used equipment as part payment on the purchase of new equipment from manufacturers or dealers and of course this class of business cannot be very pleasing to the equipment dealer. It is in the same category as having to take in a secondhand automobile in order to sell a new one, and while it is not the most desirable way of doing busi-

ness it is probably something that cannot be prevented.

On our most important work, and particularly on rush jobs, we have pretty generally used nothing but new equipment because we could not take the chance of shutdowns due to faulty or worn out equipment. On some of our work, however, we have bought used equipment, sometimes from dealers and sometimes direct from another contractor, and in all such cases have felt qualified to judge of the condition of the equipment we were buying. As a rule we have gotten as good service from such used equipment as we expected to get.

When we sell used equipment we recondition it so that it is in our belief serviceable and in a condition we would wish it to be if we were going to put it on one of our own jobs. It is often true, however, that equipment which we would think should not be placed on a large and important job which would run for perhaps many months would be entirely suitable for a smaller or shorter job. In other words, it may have had 50 to 75 per cent of its life used up on the job for which it was purchased, but the remaining percentage may fit very nicely the life of a smaller job. In such a case it should prove both satisfactory and economical to buy used equipment.

If a contractor can assume that he will keep steadily busy on a class of work that will require about the type of equipment and about the same size units of equipment, we think the most economical thing is to buy new equipment and wear it out and then buy new again. Like the automobile all equipment will reach a point where it is not economical to operate it and when it reaches that point the original owner can't afford to waste his time with it. Nor can any one else afford to buy it.

But if the contractor's work is more or less intermittent and if on one job he needs a ½-yd. mixer and on the next one he needs a 2-yd. mixer he will operate most economically if he can buy equipment which has in it just life enough to complete the job on hand. In other words, if a contractor has a job involving the pouring of 25,000 yd. of concrete and he can buy a mixer that is in good shape for that amount of work it is better business for him to buy such a mixer than to buy a new one which might be good for 50,000 yd. and which would be only half worked out at the end of his job. This would be particularly true where the size of mixer used was one that might not be needed by the contractor again for a long time. We speak of mixers only by way of example. The same principle carries through all kinds of equipment.

Generally speaking, nobody gains much by using secondhand equipment, but as stated above there are cases where it can be used advantageously and as some one has to wear it out there will always be the necessity of some one handling it. If the equipment dealer refuses to handle it and contractors buy and sell between themselves probably the dealer will lose more in the end than he will gain.

By Wayne Pringle
Chief Engineer, Woods Bros. Construction Co., Lincoln, Neb.

IN OUR opinion it is necessary at various times, both to buy and to sell used equipment. Many times when a small job was to be done and no new equipment was near at hand, we would have been exceedingly glad had we been able to buy some first class used equipment for this particular job, which would not have stood for purchase of new equipment.

In a case of the small contractor, used equipment seems to be absolutely essential in a majority of cases.

In order to make a comparison between the handling of used equipment by the manufacturer, we might cite the automobile business as it is handled today. When a purchaser wants to buy a new car he trades with manufacturer or dealer, handling new machines, his old car at a specified price. This was not true years ago, but recently it has stimulated a greater business for the manufacturers and has also made it possible for the automobile users to enjoy, at a less cost, the ownership of a comparatively new machine at all times. We think this would apply directly to the contractor.

By Charles W. Wagner
President, Capital Construction Co., Des Moines, Iowa

WE ARE thoroughly satisfied with the way the disposal of used equipment is being handled now.

As a usual thing in the purchase of new equipment we are able to turn in as part payment our used equipment. The only trouble with this is, for instance, if we are in the market for a new mixer, we must deal with the same people that handle our old mixer which we wish to trade in. This of course forces us to purchase the same make of mixer, when we might wish to trade in another make.

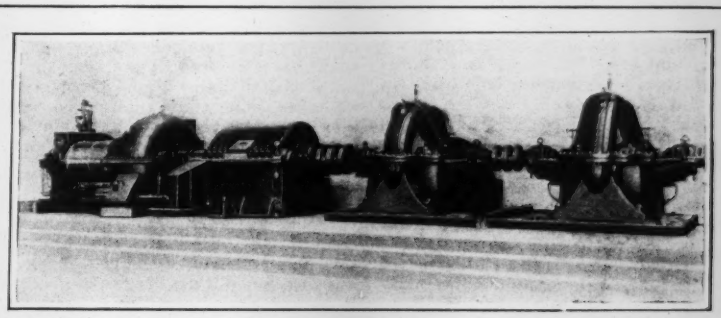
It is a well known fact that in selling construction equipment to secondhand dealers the contractor is not able to receive very much for it. However when it comes to the point of buying, there seems to be quite a difference in price. As long as the equipment men deal in that line of business there seems to be no reason why they should not handle used equipment the same as they do new equipment.

Chlorinating Patent Decision Cannot Be Appealed

The Supreme Court of the United States on Nov. 23 denied the application of the Paradon Engineering Co. that it be allowed to appeal the decision against it by the Circuit Court of Appeals in New York in regard to infringement on the Ornstein patent for the solution feed of chlorine. Following the granting of a permanent injunction last May by the Circuit Court of Appeals in New York, the Paradon Co. equipped some of its apparatus previously sold with a "Bull Pot" being a steel pipe 36 in. long and 3 in. dia. to the ends of which are attached pieces of rubber hose for intake and discharge of the chlorine for the pipe. By filling the "Bull Pot" with iron particles it was claimed that the Ornstein Patent was not infringed. One of the users of this Bull Pot was Garden City, Long Island, against whom an action was brought by the Electro Bleaching Gas Co. and Wallace & Tiernan Co., Inc., claiming that the use of this apparatus was a continuation of the use of the Ornstein process. Judge Marcus B. Campbell, United States District Court for the Eastern District of New York, handed down a decision on Oct. 30 directing that a preliminary injunction should issue restraining the village from continuing to operate the apparatus. The village may continue to operate it for the purpose of making ferric chloride which is stated as the purpose of the Bull patent but not for the purpose of applying chlorine solution to the water to be purified.

Court Again Sustains Patent for Pneumatic Concrete Placement

In August, 1925, Judge Hand in the United States District Court, Southern District of New York, sustained the McMichael patent for a pneumatic concrete placer as held by the Concrete Mixing & Conveying Co., who had brought suit against the Ulen Contracting Corp. and the Shandaken Tunnel Corp. In retrying the same issue with the same plaintiff but this time with the Powers-Kennedy Contracting Corp. and Anthony G. Fleck as defendants, the same court has handed down a similar decision. By these decisions the right to manufacture concrete ma-



Said to Be Largest Water-Works Centrifugal Pumping Unit

Installed at the Florence pumping station of the Metropolitan Utilities District, Omaha, Neb. It consists of two Worthington volute pumps with a capacity of 50,000,000 gal. per day against a 280-ft. head.

chinery for pneumatic placement, by conveying slugs of concrete separated by air pockets as provided by the McMichael patent, is virtually restricted to the holder of the McMichael patent and its sole licensee, the Ransome Concrete Machinery Co., Dunellen, N. J.

Business Notes

BLAW-KNOX Co., Pittsburgh, announces that E. LeRoy Harrington is now a member of the Blaw-Knox organization as a clamshell bucket designer. Mr. Harrington has had considerable experience in designing buckets for ore, coal and slag handling installations and he will be concerned in his new position with the design of clamshell buckets suitable for special purposes. A further announcement is that EDWARD J. COSTELLO, JR., has joined the Blaw-Knox Co.'s selling staff and will cover territory adjacent to the Philadelphia office.

LINK-BELT Co., Chicago, has extended the horsepower range of its silent chain drives available from distributors' stocks from its present scale of ½ to 10 hp. up to 15 hp.

WILLIAMS FORM CLAMP Co., INC., Chicago, has appointed W. J. Burke, 200 Davis St., San Francisco, Calif., as its sole distributor on the Pacific Coast.

J. KING MCLANAHAN, JR., a director of the National Lime Association and an official in a number of companies interested in lime manufacture, died recently in Pittsfield, Mass., where he was president of the New England Lime Co. He was vice-president and chairman of the American Lime & Stone Co. and a partner in the Marblehead Lime Co., Chicago, one of the largest companies west of the Ohio River. Mr. McLanahan was 55 years old.

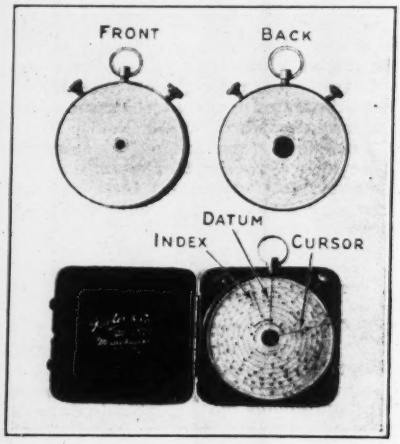
New Developments

New Circular Slide Rule Has a 30-In. Scale

Circular slide rules and pocket calculators said to be equal or better than an ordinary 10-in. slide rule in accuracy and freedom from parallax and eccentricity, have recently been developed in several different styles by Fowler & Co., 53 New Bailey St., Manchester, England.

Different types of instruments are made to meet the special needs of different trades and professions, but the two most commonly used by engineers are known as the "slide rule" type and the "long scale" type. The illustration shows the long scale type. In the slide rule type the scales are marked on an outer fixed annulus and corresponding ones radially opposite are marked on a rotating dial inside the annulus. This is, of course, a very close imitation of the construction of the straight slide rule. In the long scale type, however, which is the one recommended by the company for most accurate and easy use, there is no fixed annulus but only a rotating dial on which all the scales are marked. Three lines or indicators are necessary, designated on the drawing as the index, the datum, and the cursor. The index line is printed on the face of the dials, both front and back. The datum is fixed on the glass crystal, while the cursor is placed beneath the crystal on a transparent disk which is revolved by one of the thumb screws. The other thumb screw operates the dial.

On the front scale the outer circle of figures is used for multiplying and dividing when only rough results are needed. The inner six circles form a



continuous long scale upon which much more accurate results may be obtained. The inner six circles taken as one are used in precisely the same way as is the outer circle. The instrument is 2⅝ in. in diameter and the long scale has a total perimeter of 30 in. Calculations to two or three significant figures may be made on the outer scale, while three or four significant figures are possible with the long scale.

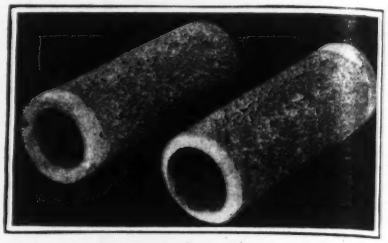
The back dial gives the values of inverse or reciprocal functions and of squares and square roots as well as sines and tangents of angles. Since the setting of the cursor line on the front dial accords with the setting of the back dial, the values of functions can be projected from the back scales to the front ones.

The instrument is $\frac{7}{16}$ in. thick and is carried in a nickel-plated containing case 2¾ in. square. Other dials are available if desired to use with the "long scale" front dial. These give such data as cubes, cube roots, metric conversion, etc. Combinations of the various dials provide 13 different types of calculators.

Porous Drainage Pipe

By using only large aggregate and cement, the Walker Cement Products Co., 1140 Broadway, New York City, has developed a drainage pipe for which it claims a number of advantages. In the first place, the pipe absorbs the water throughout its entire length, rather than just at the joints. As may be noted in the illustration, the ends of each section are made concave and convex, which is claimed to provide better alignment and less chance of displacement. Also, there is less possibility of open joints with consequent clogging of the pipes.

Although comparatively new in the

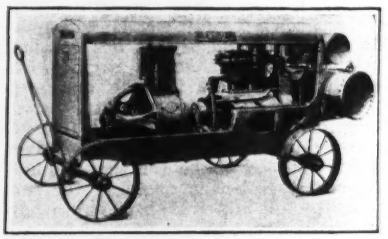


United States, it is said that this pipe has been used quite extensively for some time by European railroads. The pipe is manufactured in three sizes, (1) inside diam. 3½ in., outside diam. 5 in., length 18 in.; (2) inside diam. 5½ in., outside diam. 7⅝ in., length 18 in.; (3) inside diam. 8 in., outside 9¾ in., length 20 in. Other special sizes are made to order where local conditions require special pipe.

Portable Air Compressors Electrically Driven

Utilizing the same compressor units as the 220-ft. and 320-ft. gasoline-engine-driven machines, the line of portable air compressors recently announced by the Sullivan Machinery Co., Chicago, Ill., is driven by electric motors. The motor-driven compressors are available in capacities of 103 and 206 cu.ft. of free air per min. with 20- and 40-hp. motors respectively direct connected to the compressors. The smaller compressor is a two-cylinder vertical type, while the larger uses four cylinders placed at 90 deg. in pairs.

The unit may, in addition to the mounting shown in the illustration, be



furnished on trailer trucks, skids, or a one-ton Ford truck. The compressor is mounted close to one end of the cast-steel truck frame with the electric motor close to the other end. The air receiver is bracketed on the rear, outside of the canopy, and the water tank is mounted above the air receiver. This water is circulated through the compressor jacket by means of a small centrifugal pump driven by a pulley on the drive shaft between the motor and the compressor. The rheostat and starting equipment are mounted on top of the motor casing as shown. The compressors are equipped with air filters insuring a supply of clean air to the compressor intake. Either d.c. or a.c. motors may be supplied.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

How's Business in New England?

Shown by Engineering News-Record's Statistics Covering Fourteen Years

IS New England going back industrially, and to what extent and how fast is the competitive South rising as an industrial region? Various replies have been submitted to cover these questions. *Engineering News-Record* here presents its own contract statistics for 1913 and for 1919 to 1926. The figures are for contracts of the following costs or more: water-works, excavation, drainage, river and harbor improvements, etc., $15,000; other public works, $25,000; industrial buildings, $40,000; commercial and educational and religious buildings, $150,000.

The table gives the actual value of all construction contracts and of commercial and industrial building for New England and the South since 1913. To determine whether construction in either section is increasing or decreasing in relation to the rest of the country, the actual contract values have been reduced to percentages of the amount for the entire country. These percentages are italicized in the table.

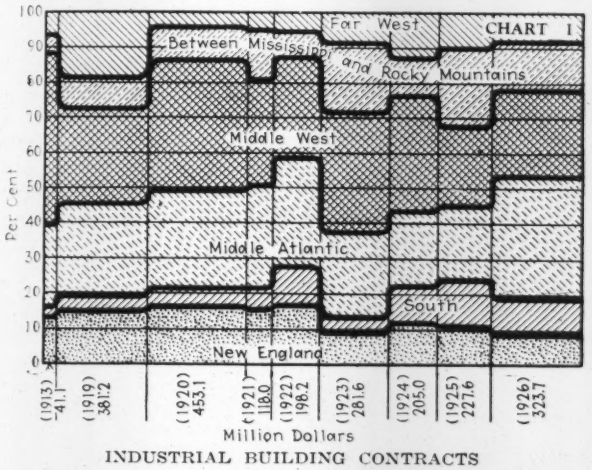
The diagrams tell the same story, except that all sections of the country have been included. The width of the bar is proportional to the actual value of construction. The height of each section corresponds to its per cent of the total for that year.

Out of the many year-to-year fluctuations, two or three distinct tendencies may be discerned. New England's industrial building, although increasing every year in actual amount, is losing in importance when compared to the country as a whole. The South on the other hand shows a corresponding growth. From 1913 to 1926 the South increased from 13 to 105 per cent of the New England amount.

In 1920, the boom year for industrial building, New England reached its highest percentage, whereas the South lost slightly in its share of the total. New England evidently had a more pronounced peak during the boom than the South. In 1922 the South doubled its percentage, and the following year New England fell almost one half. It picked up somewhat in 1924, but continued falling in the succeeding two years. In 1925 and 1926 the South caught up with New England and is now one and a half million dollars ahead.

The total amount of construction follows fairly closely the movement of commercial buildings because of the fact that the latter comprises from 40 to 50 per cent of the total.

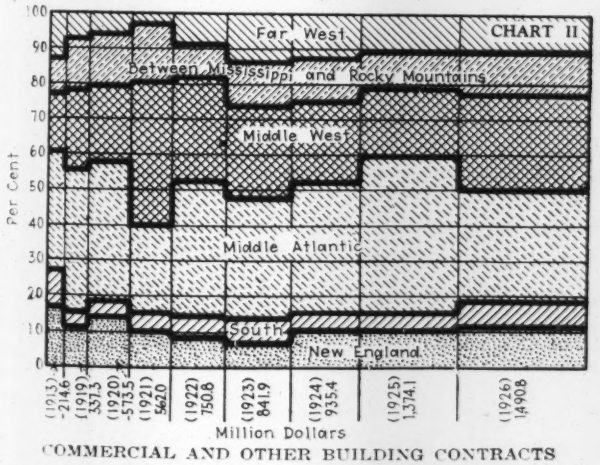
Commercial building in New England dropped in relative importance until 1924, when it began picking up again. This was the year following the big decrease in industrial building. This fact raises the question whether New England is on the point of turning from an industrial to a commercial center.



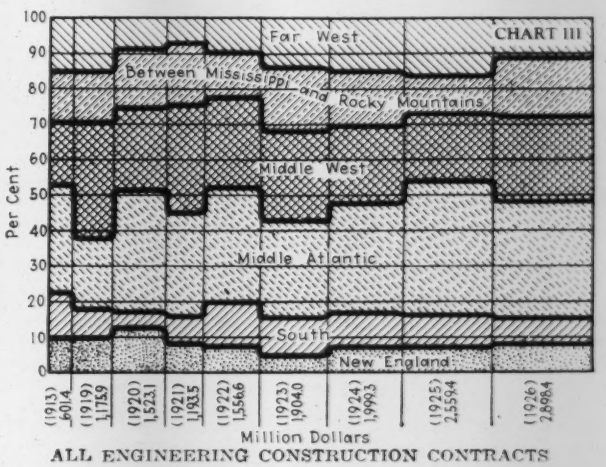
INDUSTRIAL BUILDING CONTRACTS

CONSTRUCTION IN NEW ENGLAND AND THE SOUTH SINCE 1913

	—New England—			—South—		
	Total Constr.	Coml. Bldg.	Ind. Bldg.	Total Constr.	Coml. Bldg.	Ind. Bld
1913 million dollars...	59.8	38 1	5.6	80 8	21.1	0.7
Per cent of U. S..	*9 9*	*17 7*	*13 7*	*13 6*	*9 8*	*1 6*
1919 million dollars...	117 4	40 5	57 5	82 6	11 2	17.6
Per cent of U. S..	*10 0*	*12 0*	*15.1*	*7 1*	*3 3*	*4 6*
1920 million dollars...	190 8	84 4	78.2	91 5	21 1	19.4
Per cent of U. S..	*12 5*	*14 7*	*17 2*	*6 0*	*3 7*	*4 3*
1921 million dollars...	100 7	57 6	19 2	96 1	30 0	6 5
Per cent of U. S..	*8 4*	*10 3*	*16 2*	*8 0*	*5 3*	*5 5*
1922 million dollars...	123 6	65 3	33 8	178 2	44 4	21 8
Per cent of U. S..	*7 9*	*8 7*	*17 0*	*11 4*	*5 9*	*11 0*
1923 million dollars...	99 1	55 5	24 8	204 3	64 5	13 7
Per cent of U. S..	*5 2*	*6 6*	*8 9*	*10 7*	*7 7*	*4 9*
1924 million dollars...	151 6	95 8	25 8	208 1	52 6	19 4
Per cent of U. S..	*7 6*	*10 2*	*12 6*	*10 4*	*5 6*	*9 5*
1925 million dollars...	99 4	146 2	26 9	248 0	81 6	27 9
Per cent of U. S..	*7 8*	*10 7*	*11 8*	*9 7*	*5 9*	*12 3*
1926 million dollars...	244 0	172 5	29 8	291 2	91 7	31 4
Per cent of U. S..	*8 4*	*11 6*	*9 1*	*8 7*	*6 1*	*9 7*



COMMERCIAL AND OTHER BUILDING CONTRACTS



ALL ENGINEERING CONSTRUCTION CONTRACTS

Weekly Construction Market

DESPITE a seasonal let-up in the amount of construction out for bids, proposed work is well in advance of 1925 and still gaining. Last year at this time this tendency was not so well marked.

Production schedules in the materials manufacturing industries have been adjusted to demand with the result that neither an excess nor a shortage exists, except where the supply is affected by transportation.

A majority of the price changes which occurred during the last week were in a downward direction. The principal materials affected were, cast-iron pipe, reinforcing bars, wrought-iron pipe and hollow building tile. These reductions were at warehouses rather than at mills and represent practically a seasonal movement consistent with the actual physical volume of construction. Canadian iron and steel prices are firm with upward tendencies in the Montreal district.

Throughout the United States finished steel demand is slack and the same condition prevails all the way back to pig-iron. Improvement is expected shortly in railway and automotive materials, sheets and strip steel.

Prices of semi-finished steel, bars and rolled material generally, are firm. Fabricated brass and copper quotations are lower this week at New York warehouses.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.15	+$4.00
Structural rivets, 100 lb.	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	—3.25	—2.30@2.50	2.87½	3.77½	2.95	3.10	+3.25
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	—54%	51%	54.25%	41%	49.7@54.1%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	—50.60	45.25	+56.00	—47.20	53.00	64.00	—49.00	55.00	+55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.50
Sand, cu.yd.	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.25
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	40.50	38.75	34.75	27.00	25.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	+1.85	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	—.11	.088	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1027	.0895	—.11	.088	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.86¼	.99¾	+1.18	.84	.+93¾	—1.06	—.98	1.12	1.05
Common Labor									
Common labor, union, hour	.90⅝	.30		90	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	—.40	.....	.45@.60	40@.45	.50	.....	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Dec. 2 the next on Jan. 6.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.95). Bag charge is 80c. per bbl. Discount of 10c per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

A Correction

In *Engineering News-Record*, issue of Nov. 11, p. 810, under the caption, Detail Replacement Costs of an Office Building Erected in 1914, reference was made to figures "based on data furnished by F. E. Barnes, chairman of the New York-Pittsburgh Association of Valuation Engineers." This statement should have read "chairman of the Building Committee, New York-Pittsburgh Assoc. of Val. Eng'rs."

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
Dec. 9, 1926	$21,088,000	$25,913,000	$47,001,000
Dec. 2, 1926	24,629,000	40,049,000	64,678,000
Dec. 10, 1925	12,554,000	31,584,000	44,138,000

January 1 to date

	Public	Private	Total
1926	$1,041,184,000	$1,697,471,000	$2,738,655,000
1925	993,986,000	1,424,416,000	2,418,402,000